MECHANICAL ENGINEERING

· NOVEMBER 1950 ·

Furnace Brazing of Machine Parts—Part 1 . . . H. M. Webber 863

An Engineering Approach to Stabilized Prosperity . . E. G. Nourse 870

Electrostatic Collection of Fly Ash . . . . . H. J. White, L. M. Roberts, and G. W. Hedberg 873

The Huey Gas Turbine . . . . . C. C. Willis and E. C. Goldsworth 881

Considerations in Designing Tools for Powder Metallurgy . . . . . I. J. Donahue 886

The Return on Investment . . . . . H. J. Lang 890

What Program for ECPD? . . . . . H. S. Rogers 895

Standards for Citizenship . . . . . A. T. Vanderbilt 897

Departments

Briefing the Record, 901

ASME Technical Digest, 912

Engineering Profession—News and Notes, 930

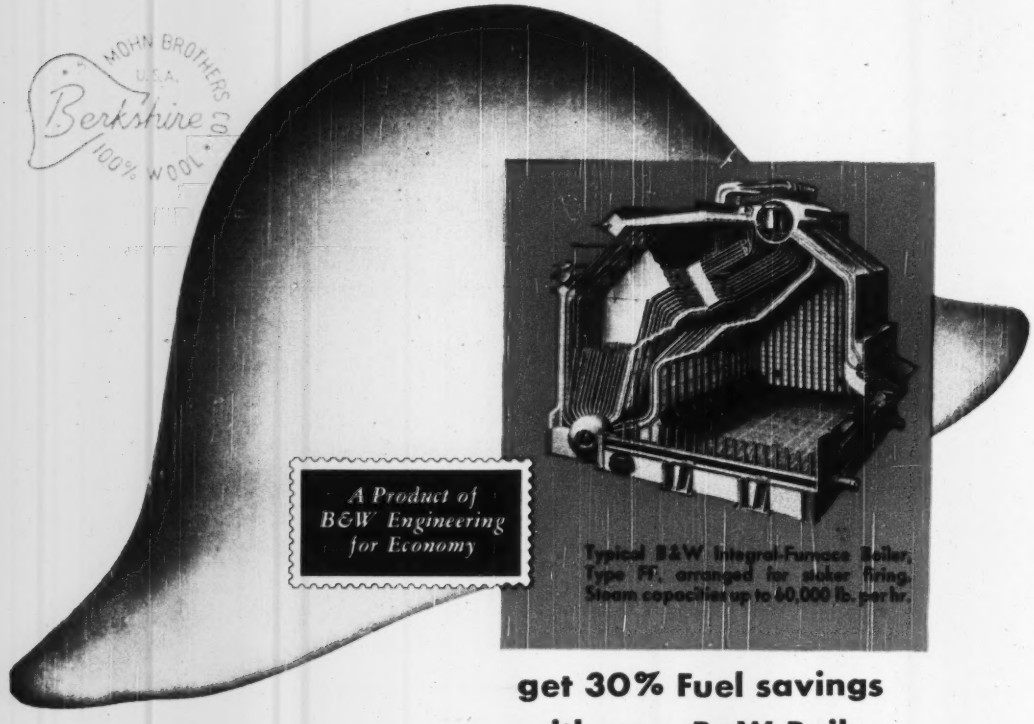
ASME News, 938

Buyer's Catalog Guide (Advertisers), 41

Power Show Guide, 87

ASME 1950 ANNUAL MEETING, New York, N. Y., Nov. 26-Dec. 1—See pages 938-940

MOHN BROTHERS Get ahead in hats


MOHN BROTHERS
U.S.A.
Berkshire
100% WOOL
A Product of B&W Engineering for Economy
Typical B&W Integral-Furnace Boiler, Type FF, arranged for stoker firing. Steam capacities up to 60,000 lb. per hr.

get 30% Fuel savings ... with new B&W Boiler

One of the largest manufacturers of felt hat bodies, Mohn Brothers Company of Reading, Pa., had a multiple steam-generating problem. Boiler requirements included: (1) maximum efficiency with minimum initial and operating cost; (2) provision for future expansion; (3) optimum performance over wide load range; (4) conformity to stringent smoke ordinances.

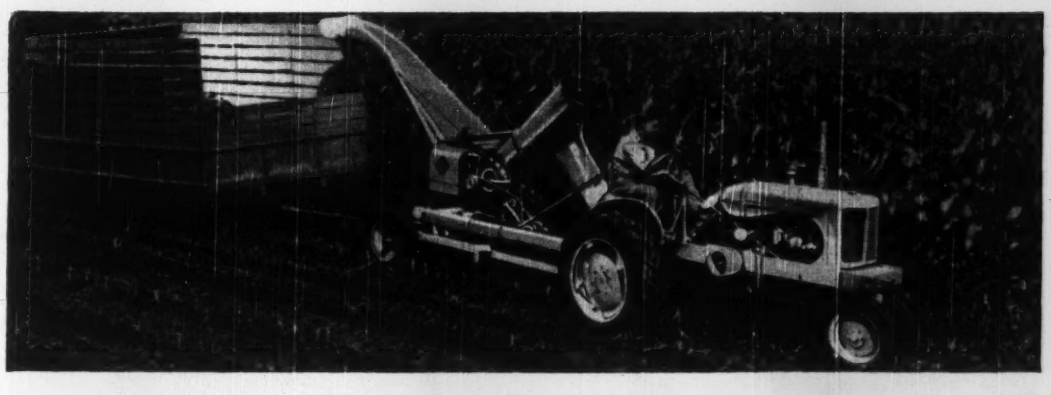
Mohn Brothers' engineers and constructors, Gilbert Associates, Inc., applied big-plant planning to the problem . . . recommended, purchased, and installed a new, stoker-fired B&W Integral-Furnace Boiler, Type FF, of 21,500 lb. per hour saturated steam capacity. Results: 30% savings over previous fuel-cost . . . operating labor down . . . provision for expansion . . . pressure uniform over wide load swings . . . smoke abatement regulations more than satisfied.

Do you have similar problems in steam for power, processing, or heating? Write to America's 80-year-old firm of boiler specialists . . . for new Bulletin G-71. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

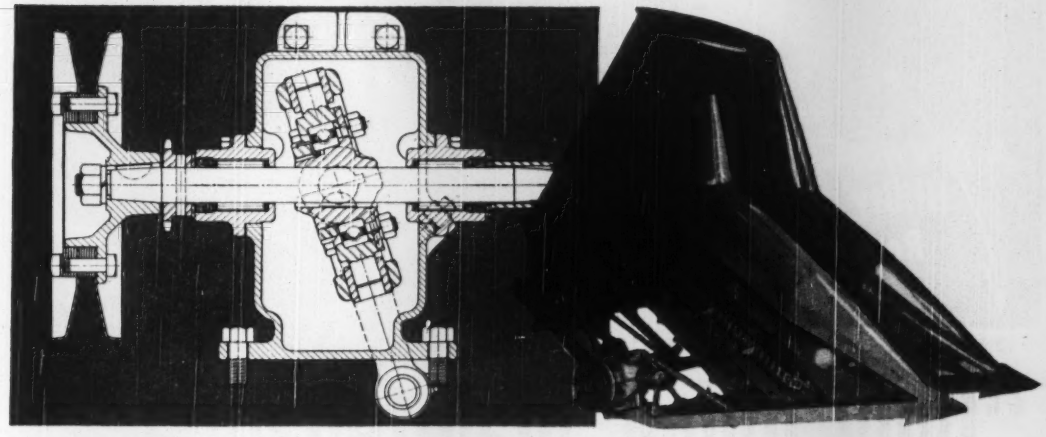
Helping Industry Cut Steam Costs Since 1867

B&W BABCOCK & WILCOX

G-503



Double Action Bearing



TRANSLATING rotary motion into reciprocating motion for the sickle drive on the row-crop attachment for the Allis-Chalmers Forage Harvester is not a job for a bearing that can't put up with variety in its life—a daily round of dizzy motions and alternating loads.

One compact New Departure single row ball bearing does the job because taking thrust in both directions as well as radial load is fundamental to its design. Without need for adjustments, this bearing uniquely combines the required internal rigidity with utmost freedom of rotation and here it is fully enclosed against dirt—needs minimum attention for lubrication.

Nothing Rolls Like a Ball

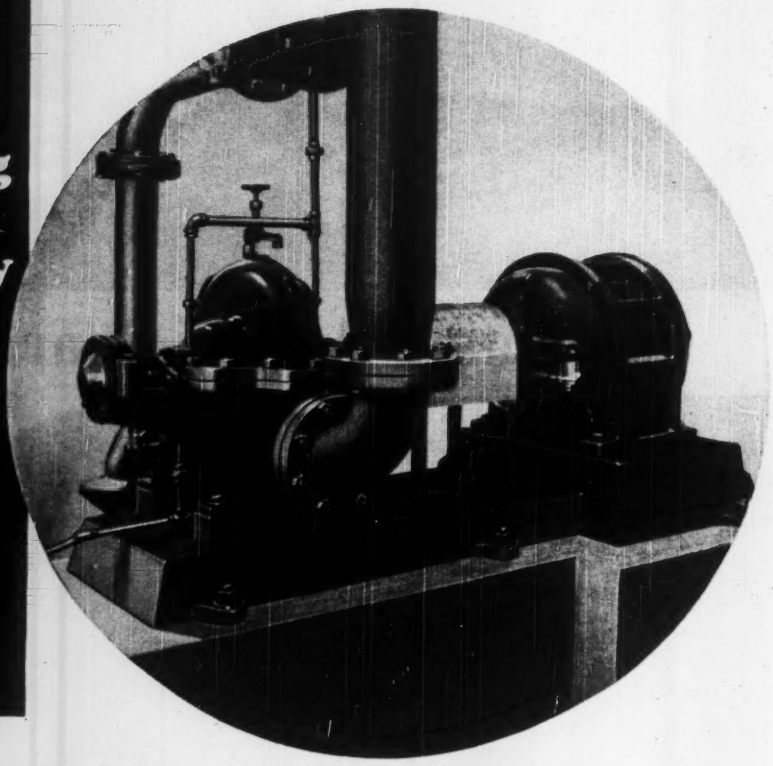
NEW DEPARTURE BALL BEARINGS

NEW DEPARTURE · DIVISION OF GENERAL MOTORS · BRISTOL, CONNECTICUT 117-C

MECHANICAL ENGINEERING, November, 1950, Vol. 72, No. 11. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢, to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

Pumping with Economy

A Midwest Utility Reports:



"Only minor maintenance over 3500 hours service"

Recirculating water at 100°, PH 5.0, this Economy 6" x 5" Type M double suction centrifugal pump replaced a conventional pump that did not stand up under the corrosive effect of water laden with tar acids, light oils, fly ash and small amounts of suspended silt. The user of this all-bronze Economy pump, a large mid-west utility, reports satisfactory service . . . minor maintenance.

Longer service with less maintenance is typical of Economy Pumps. Many improvements in design, workmanship and materials contribute to their higher efficiency, greater dependability and longer life.

For complete details on Economy Type M double suction pumps, write Dept. CM-11 for Catalog A-1147. For competent engineering advice on any pumping problem, call on your Economy Pump Representative.

Centrifugal, axial, and mixed flow pumps for all applications.

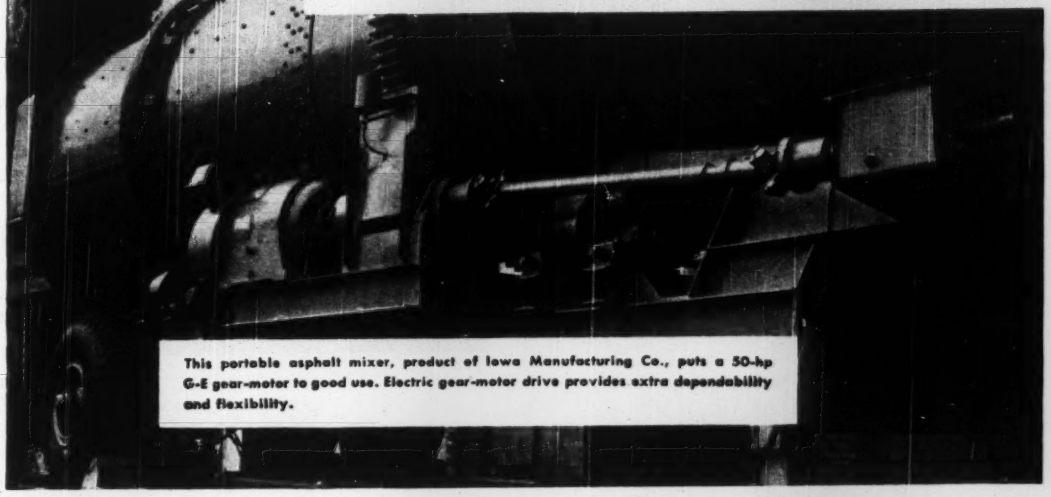
Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP. HAMILTON, OHIO

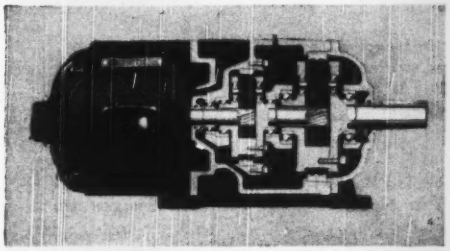
Yes! we said gear motors

UP TO 150 HP

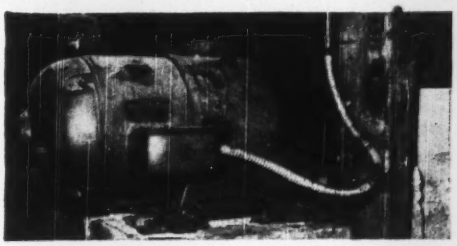
for dependable low-speed drive



This portable asphalt mixer, product of Iowa Manufacturing Co., puts a 50-hp G-E gear-motor to good use. Electric gear-motor drive provides extra dependability and flexibility.



Planetary gear reduction gives you smooth transmission with the greatest load-carrying capacity in the smallest space.



In another asphalt-processing operation, easy starting and smooth operation of this 60-hp Tri-Clad gear-motor are producing substantial savings. The gear-motor replaced a steam-engine drive.

G-E TRI/CLAD GEAR-MOTORS

compact, efficient, extra-protected

Even for large low-speed drives up to 150 hp, there's a G-E gear-motor that can fill the bill. With it you eliminate separate gears or reducers, because you buy only one compact, pre-engineered power package. You save purchasing and engineering costs by specifying one unit to do the job.

In hazardous areas, too, G-E explosion-proof gear-motors offer extra protection for applications where open gears, belts, and pulleys are prohibited . . . and in addition to these features, you get:

UNIT RESPONSIBILITY— G.E. assumes unit responsibility for both gear and motor, whether it's rated at 1 or 150 hp. You avoid many design and purchasing problems.

PRE-ENGINEERING— G-E gear-motors are pre-engineered to work as a unit, give you the best possible combination of gear and motor for your job.

OVER-ALL PROTECTION— Integrated housing shields the whole unit from dust and dirt, permits application where chains and belts cannot be used.

Standard ratings up to 75 hp are available from stock, and special quotations are issued for ratings up through 150 hp. To fill your needs on all gear-motor requirements, call your nearest G-E Sales Office or your local distributor. Apparatus Dept., General Electric Co., Schenectady 5, New York.

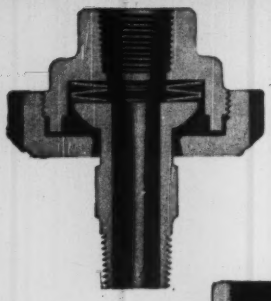
GENERAL ELECTRIC

755-5

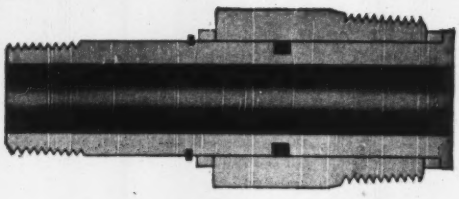
BARCO Flexible, Swivel and Revolving Joints

A complete range of design

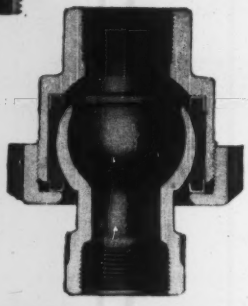
Select the one fitted to your specific needs



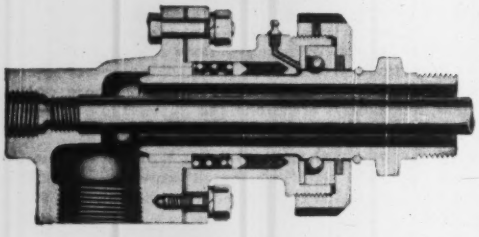
Barco Rotary Swivel Joints for use with air, oil, gas, steam, water and other fluids provide slow rotation with side flexibility.



Barco Swing Joint for hose reels, loading and unloading lines, and for tank cars and trucks—compact, inexpensive, durable.



Barco Flexible Joints for conveying oil, steam, gasoline, water, tar, corrosive acids and alkalis —where flexibility in piping is required.



Barco Revolving Joints supply steam, gas or other fluids from a fixed supply pipe to a rotating drum or member with low friction "drag." Sizes from ¼" to 5".

There is a Barco Joint for each particular problem in pipe flexibility. Different designs are available for:

- **Combined angular and swivel motion**
- **Swivel and slow rotation combined with angular motion**
- **Swing action with no side flexibility**
- **High-speed rotation**

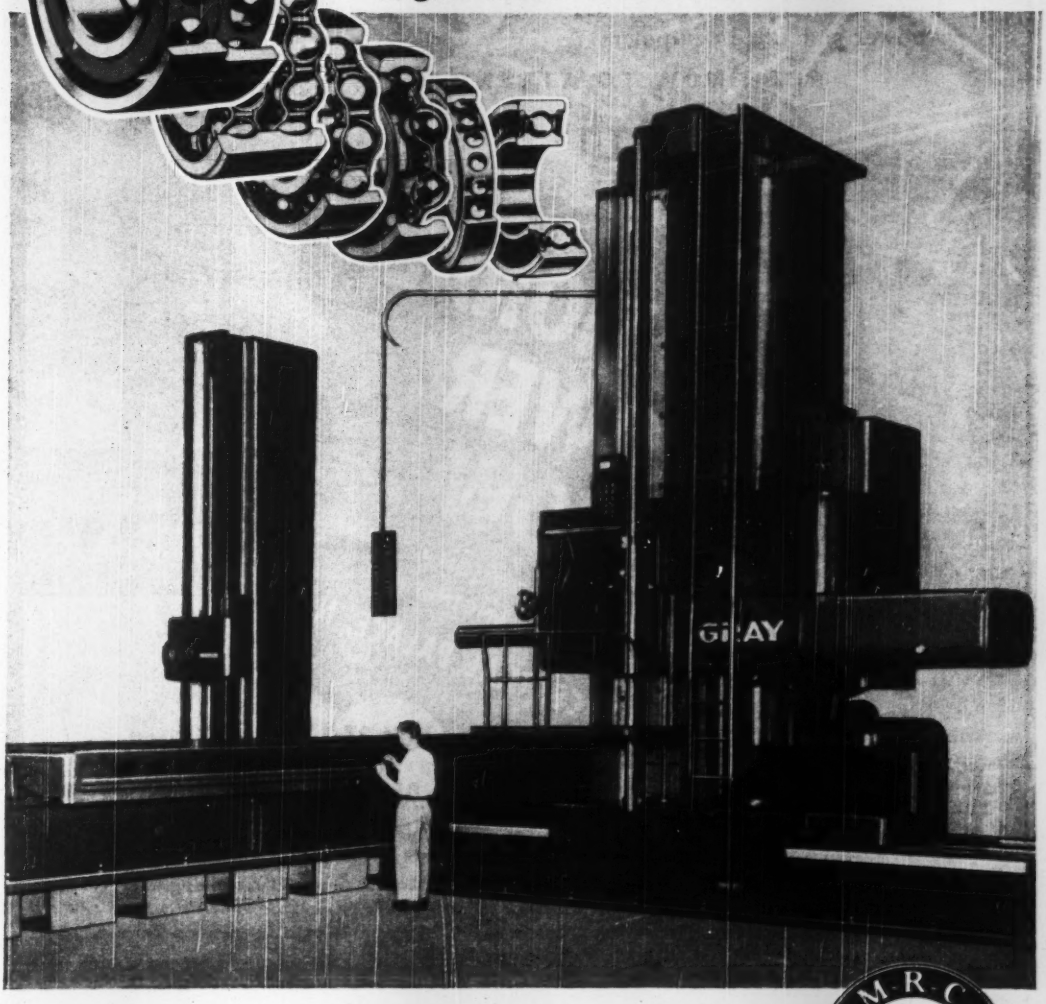
There's a Barco Joint to handle any type of fluid with wide temperature and pressure ranges and a variety of metals and gasket materials. For more information about this *complete* line of joints, write Barco Manufacturing Company, 1807L Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal.

BARCO THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL AND REVOLVING JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

75 M-R-C Ball Bearings

contribute to the efficiency of one of the largest machine tools built in recent times



New GRAY 8" PLANER-TYPE HORIZONTAL BORING, DRILLING AND MILLING MACHINE.
This 175 ton machine is capable of supporting castings weighing 85 tons.
Manufactured by G. A. Gray Co., Cincinnati, Ohio for Hydraulic Press Mfg. Co., Mt. Gilead, O.

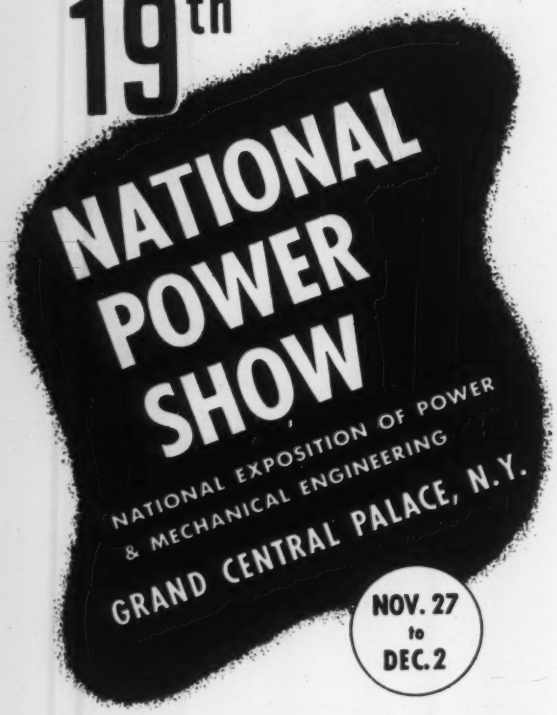
M·R·C Strom SRB GURNEY BALL BEARINGS

MARLIN-ROCKWELL CORPORATION
Executive Offices: JAMESTOWN, N. Y.

"TIME WELL SPENT"—you'll say

New money-saving ideas were never more important than NOW to combat high costs and keener competition. That's why you and your associates can't afford to miss this foremost presentation of power and allied equipment.

PLAN NOW TO ATTEND THE.....



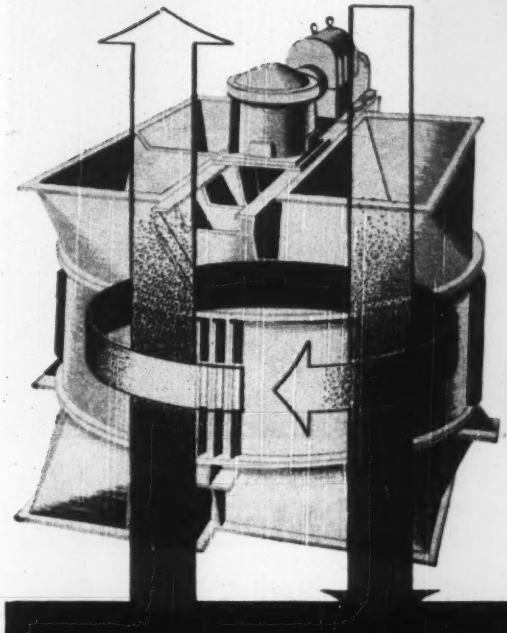
NEW IDEAS! Over 300 manufacturers showing, demonstrating, and explaining latest techniques, equipment, and materials for more efficient power production and utilization, materials handling, and plant services . . . newest and best ways to expand and modernize for greater operating and maintenance economy.

ASK THE EXPERTS! An unequalled opportunity to get first-hand technical advice on adapting new cost-saving equipment, supplies, and methods to your present operations and future plans. In no other way can you get so much help on your power problems in so little time.

Make it a Must for New Ideas—Bring Your Associates

Auspices ASME in conjunction with Annual Meeting

Management International Exposition Co.



this preheater is cutting fuel costs in hundreds of plants

the *Ljungstrom* AIR PREHEATER

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

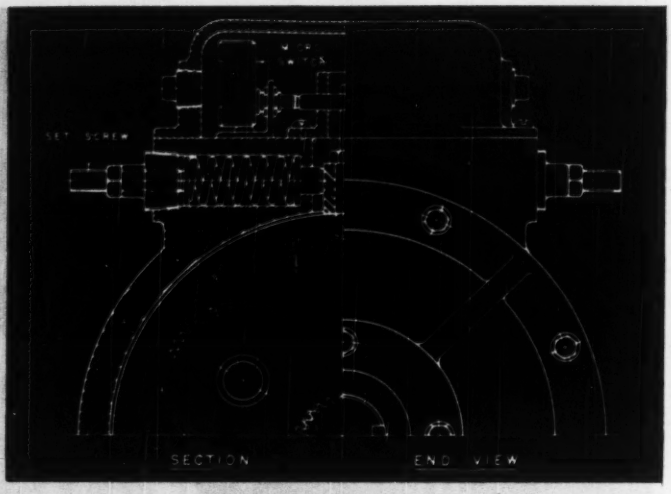
The Ljungstrom air preheater has proved its value in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

Your fuel costs will be lower too, when your boiler is equipped with the Ljungstrom air preheater. The regenerative design of the Ljungstrom permits reliable operation at low exit gas temperatures. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

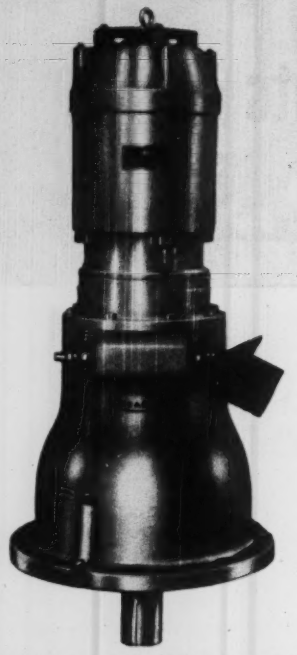
If you are planning a new installation, or expanding your present one, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the overall efficiency of *your* plant.

THE AIR PREHEATER
60 East 42nd Street, New York 17, N. Y.
CORPORATION

Positive Protection from OVERLOAD DAMAGE



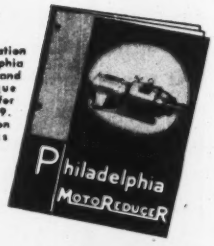
PHILADELPHIA PLANETORQUE MOTOREDUCER



CUTS OFF MOTOR CURRENT INSTANTLY AND AUTOMATICALLY

. . . when the load reaches a predetermined value, thus protecting both the driven machinery and the drive unit from overloads. This feature can be provided on any MotoReduceR . . . either vertical or horizontal types. On removal of the excessive load the PlaneTorque MotoReduceR may be started without resetting the switch. Incidentally, the PlaneTorque can be cut out during the starting period, by merely holding down the starting button; upon release PlaneTorque is again operative. The PlaneTorque is ideal for Stoker drives, Conveyors, Crushers, Mixers, Rolls, Pulverizers and a "hundred and one" other machines. MotoReduceRs are available in all required Horsepowers and Reduction Ratios. Efficiencies are as high as 97%.

For full information about Philadelphia MotoReduceRs and the PlaneTorque feature, send for Bulletin MR49. Please write on your Business Letterhead.



Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
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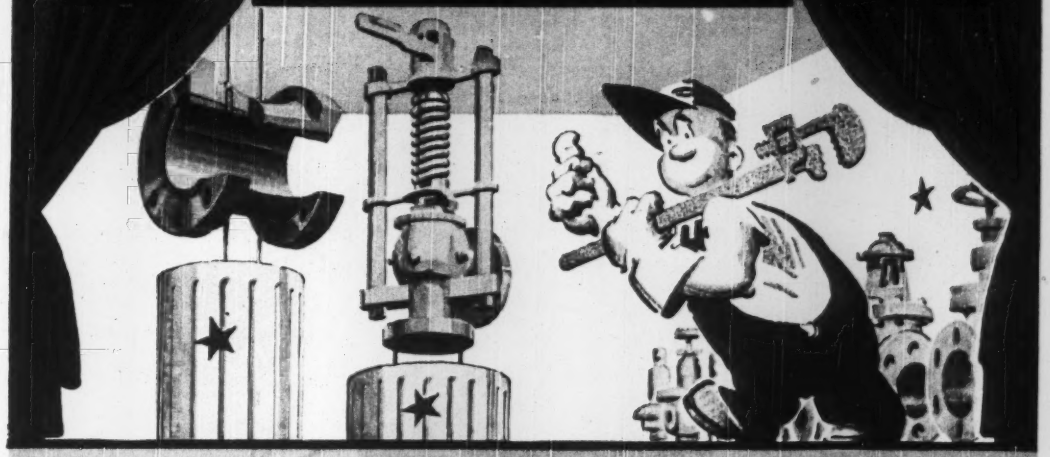
Industrial Gears and Speed Reducers
LimiTorque Valve Controls

STAR PERFORMERS at the 19th National POWER SHOW

Grand Central Palace, N. Y., Nov. 27-Dec. 2—Booths 38-39

FOSTER ENGINEERING Company



★ **FOSTER FLOW TUBE**
(Gentile Patents)

The revolutionary differential producer for metering flow of liquids and wet or dry gases:

- **Compact . . .** short spool piece
- **Easy to Install . . .** like a fitting
- **Reversible . . .** reads flow in either direction
- **Low Head Loss . . .** low main-to-throat ratio
- **Accurate . . .** equal or superior to conventional primary elements in accuracy

★ **FOSTER 38-SV**

The revolutionary safety valve that has shattered all performance records. Guaranteed advantages:

- Tight Seating
- Consistently Accurate Popping
- Minimum Blow-Down (can be held to as little as 1%)
- Highest Relief Capacity for a nominal valve size
- Extremely Low Maintenance

★ **FOSTER AUTOMATIC VALVES**

The complete Foster line has always been noted for HIGH Reliability and low Maintenance.

• • •

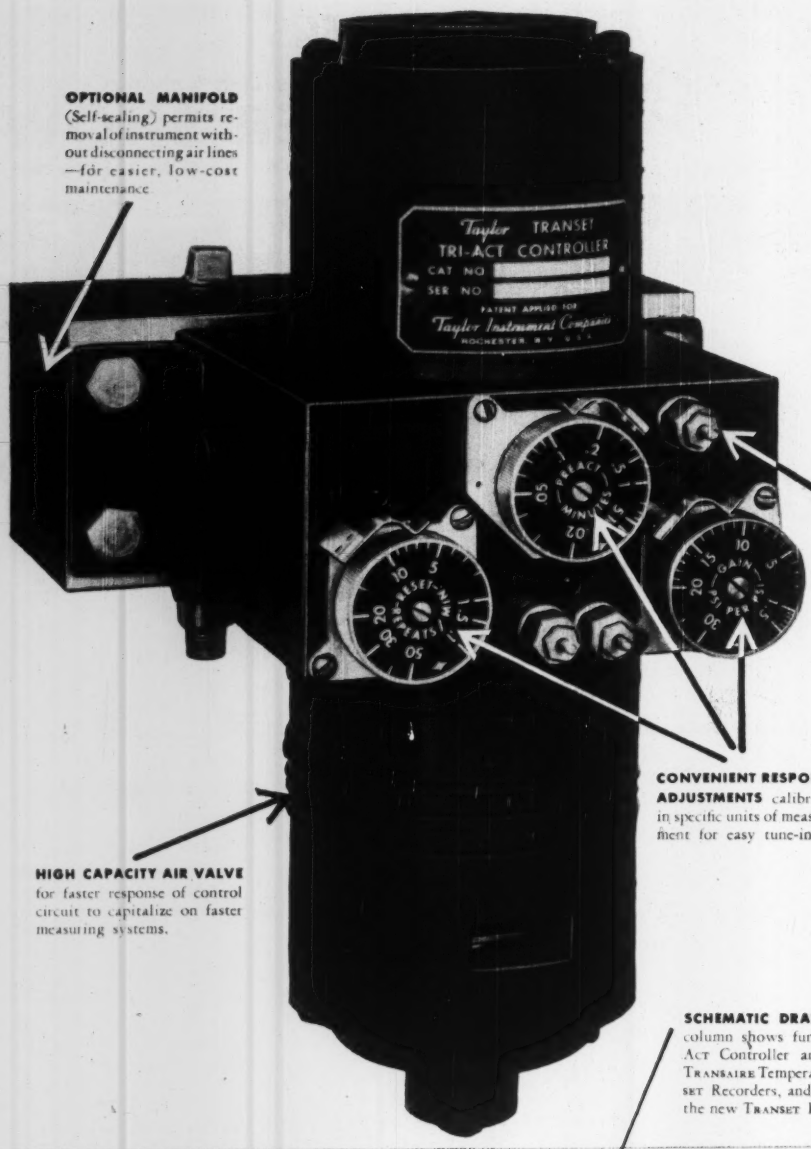
Make a note right now to see the Foster line in Booths 38 and 39, it will pay you. And if, for any reason, you can't get to the Power Show do the next best thing—drop us a line, and we'll send you a set of illustrated bulletins, many of which will be available for the first time at the show.

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SIRENS SAFETY VALVES FLOW TUBES

835 LEHIGH AVENUE • UNION, N. J.

OPTIONAL MANIFOLD (Self-sealing) permits removal of instrument without disconnecting air lines—for easier, low-cost maintenance.

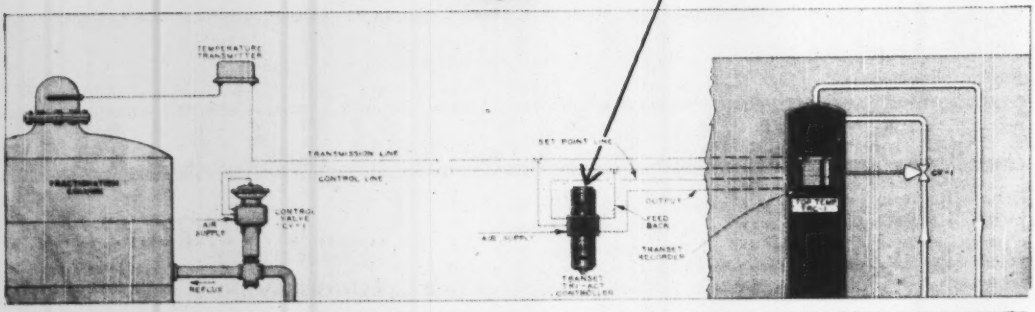


ORIFICE CLEANER!

CONVENIENT RESPONSE ADJUSTMENTS calibrated in specific units of measurement for easy tune-in.

HIGH CAPACITY AIR VALVE for faster response of control circuit to capitalize on faster measuring systems.

SCHEMATIC DRAWING of fractionation column shows function of TRANSET TRI-ACT Controller and its relation to the TRANSAIRE Temperature Transmitter, TRANSET Recorders, and TRANSET Indicators, in the new TRANSET Process Control System.



New Taylor Transet* TRI-ACT* CONTROLLER!

A Force-Balance Controller with a New Circuit

. . . a New Concept in Process Control

GIVES YOU

1. START-UP WITH *NO* OVERPEAKING
2. BENEFITS OF AUTOMATIC RESET WITHOUT ITS "EVILS"
3. FASTER RECOVERY ON LOAD CHANGES

What It Is—A force-balance controller with a new circuit for pneumatic control systems. The new control circuit combines *two* proportional bands, one with rate action in a closed loop ahead of automatic reset. The first band is shifted by the rate action, and the second band is shifted by the automatic reset. This provides control never before believed possible.

What It Does—The new circuit in the TRANSET TRI-ACT Controller permits 4 times faster reset rate and 4 times faster rate action (PRE-ACT) than conventional instruments! The composite effect of the three responses allows start-up and pneumatic setting with NO OVERPEAKING! The faster response settings allow the use of rate and reset responses, *with stability*, on processes where these effects were needed but could not be used.

OTHER HIGHLIGHTS

- Can be locally or panel mounted
- Wider range of response adjustments
- Light weight
- Built-in air strainers

TRANSET TRI-ACT Controller is the latest step in the TAYLOR TRANSET system of control: TRANSAIRE* Transmitters, TRANSET Recorders and Indicators. It creates new standards in accurate pneumatic transmission systems for temperature, pressure, flow or liquid level control.

Write for Bulletin 98097 or, better still, order now from your Taylor Field Engineer! Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

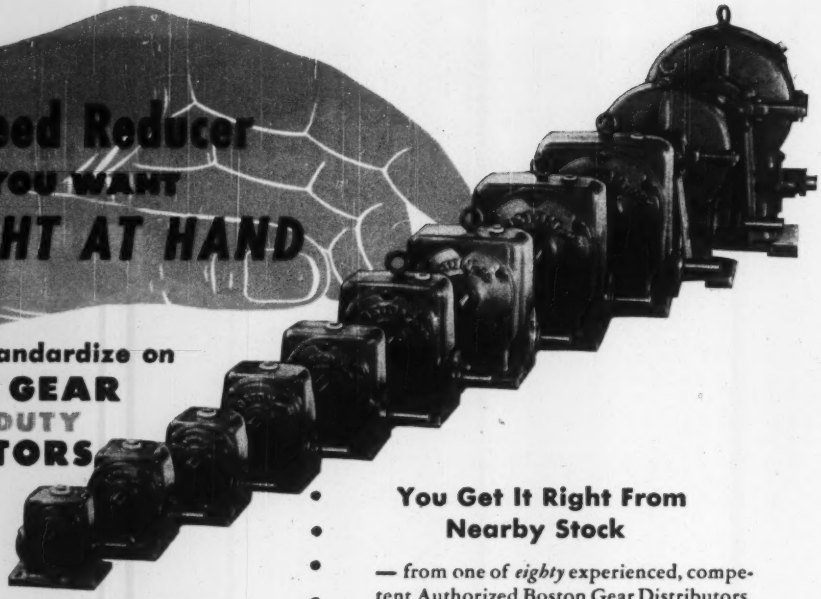
Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

*Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

The Speed Reducer YOU WANT IS RIGHT AT HAND

when you standardize on
BOSTON GEAR
HEAVY DUTY
REDUCTORS



You Get the One Best Unit For the Job

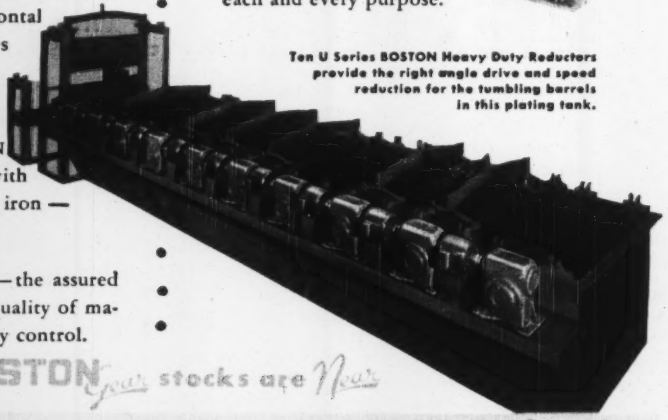
BOSTON GEAR HEAVY DUTY REDUCTORS OFFER YOU:

1. *The widest selection of types and sizes.* Pictured above is but one (T Series, Horizontal Right Angle Drive) of *eight* types — each in a range of sizes.
2. *More trouble-free horsepower per dollar.* Heavy gearing of BOSTON *Gear* quality — worm integral with shaft-housings of Boston Gear iron — rugged steel shafts.
3. *More trouble-free hours per dollar* — the assured result of Boston Gear design, quality of materials, workmanship and quality control.

You Get It Right From Nearby Stock

— from one of *eighty* experienced, competent Authorized Boston Gear Distributors.

Simply consult the new Boston Gear Catalog No. 55 (copy mailed on request). It contains ready reference charts for quick selection of the one best Reductor for each and every purpose.

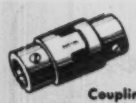


Ten U Series BOSTON Heavy Duty Reductors provide the right angle drive and speed reduction for the tumbling barrels in this plating tank.

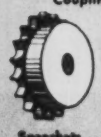
BOSTON *your* stocks are *Ours*

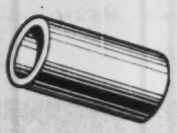
BOSTON GEAR WORKS

66 HAYWARD ST., QUINCY 71, MASS.

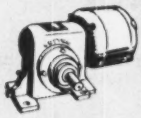

Couplings

Universal Joints


Sprockets


Bost-Bronz Bearings

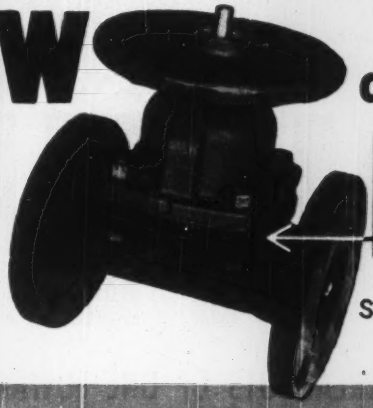
Pillow Blocks


Ratiomotors

Bearings

Gears

NOW chemically inert KEL-F* diaphragms for GRINNELL-SAUNDERS DIAPHRAGM VALVES



*KEL-F is the registered trade name for polytrifluorochloroethylene, an exceptionally stable thermoplastic produced by The M. W. Kellogg Company. Its resistance to chemical action, low cold flow, wide range of temperature application and flexibility combine to make KEL-F the most important diaphragm development in the past ten years. It is chemically inert to all inorganic acids, alkalies and the like with the exception of molten alkaline metals such as sodium. KEL-F is also chemically inert to organic materials but may be plasticized or swelled slightly by halogenated organic materials. However, test installations indicate that this plasticizing or swelling action is of minor consequence and in the majority of cases does not affect valve operation.

plus all these unique valve features

Diaphragm lifts high for streamlined flow in either direction . . . Smooth, streamlined passage, without pockets, prevents trapping of sludge and reduces frictional resistance to a minimum — irrespective of direction of fluid flow. No disc holder in fluid stream. Grinnell-Saunders Diaphragm Valves are self-draining when installed with the spindle at 15 degrees above the horizontal position.

Diaphragm absolutely isolates working parts from fluid . . . There's no "if" about the way a continuous, one-piece diaphragm seals off the working parts from fluids; no perforation or puncture in the diaphragm where fluid or gas can possibly leak by the valve spindle. No sticking, clogging or corroding of working parts. Valve lubricant cannot contaminate the fluid in the line.

Diaphragm, body and lining materials to meet particular conditions . . . Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum: other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

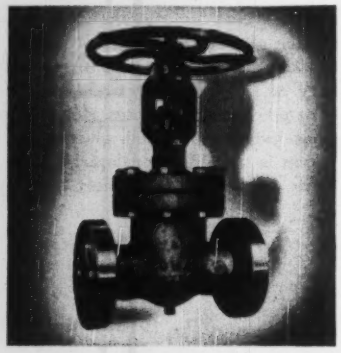
Diaphragm is only part that normally wears and needs replacement . . . Depending on the type of service, it may last for years, particularly since the compressor and finger plate combine to support the diaphragm in all positions. The diaphragm can be replaced quickly without removing valve from line. No refacing or reseating.

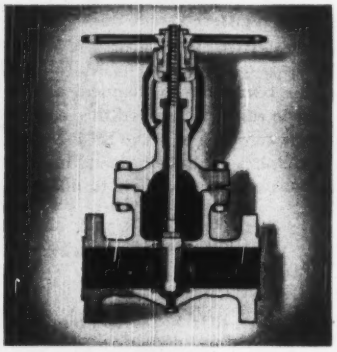
GRINNELL

Grinnell Company, Inc., Providence, R. I. Branches: Atlanta • Billings • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

WANTED

INFORMATION AS TO THE WHEREABOUTS OF ONE EDWARD GATE VALVE WHICH ISN'T PERFORMING SATISFACTORILY!





DESCRIPTION: Close fitting wedge guides prevent wear-producing wedge drag on seating faces—accurately located with respect to seating faces and wedge, then welded integral to the body while master wedge is still in place • Looseness eliminated and wear reduced to a minimum • One-piece bonnet aligns stem accurately • Needless weight and unnecessary working parts eliminated • Two tight seating faces • Ball bearing yoke makes operation easy • Uniform metal sections reduce distortion in heating and cooling • Integral but replaceable hard surfaced seats greatly lengthen valve life.

The Edward Gate Valve Apparently Has a Perfect Record—We Have Literally No Information on Service Complaints!

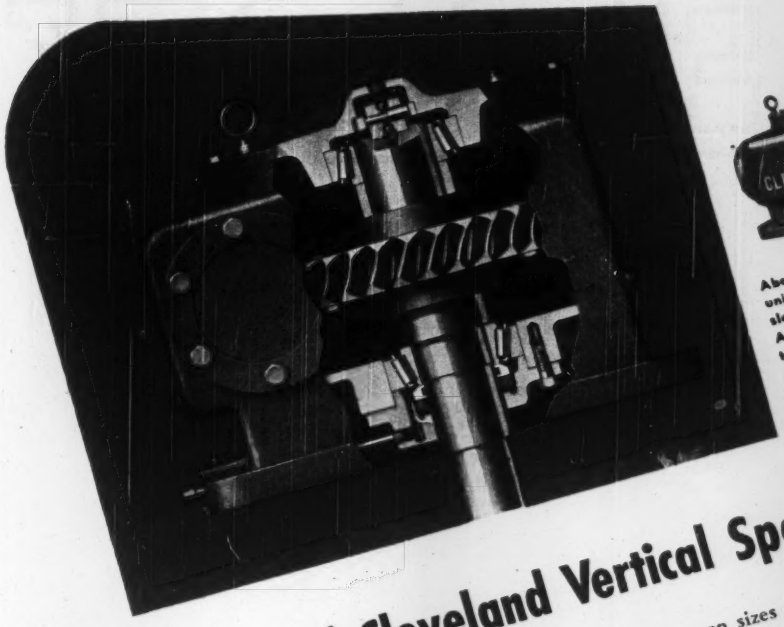
Since the Edward Gate Valve was introduced, not one valve deficiency has been recorded. Our men are still on the lookout for information concerning the whereabouts of an Edward Gate Valve in need of service. If you know of, or can find, any Edward Gate Valve requiring attention, please contact your Edward Valve representative, or get in touch with our main office. Your help will be greatly appreciated.

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA



Above—Exterior view Type ND unit. NU unit (not shown) has slow-speed shaft extending up. At left—Cutaway section to show tapered roller bearings on gear shaft, positive face-type oil seal, unique lubricating pump and oil drain at base of housing.

A new series of Cleveland Vertical Speed Reducers

● NU and ND worm gear units—in seven sizes each (50 to 500) are ready for prompt delivery. They are particularly suited to such equipment as agitators and mixers, and to overhead chain conveyors as well.

Outstanding features which insure that these new vertical drives will deliver long and trouble-free service are:

Extra heavy tapered roller bearings on gear shaft.

Continuous lubrication of top bearing by positively driven pump mounted on upper end of gear shaft (on lower end in Type NU).

Positive face-type oil seal below lower gear shaft bearing to prevent leakage.

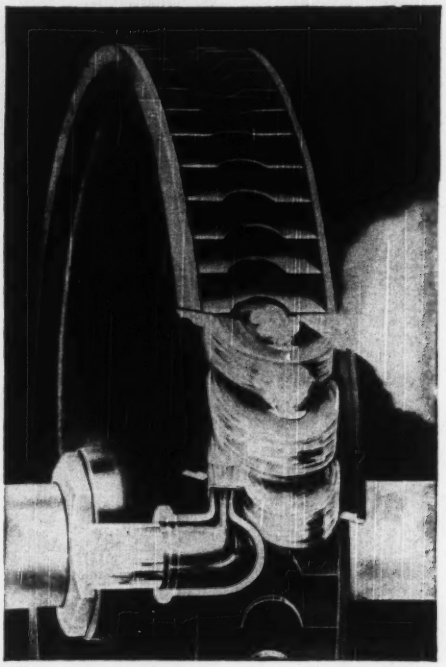
Heavy base flange extends around all four sides. All parts liberally sized and precision built.

Write for Bulletin 125 for full description of Types NU and ND, including capacity charts and dimension data. The Cleveland Worm & Gear Co., 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Speed Reducers

TERRY



Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

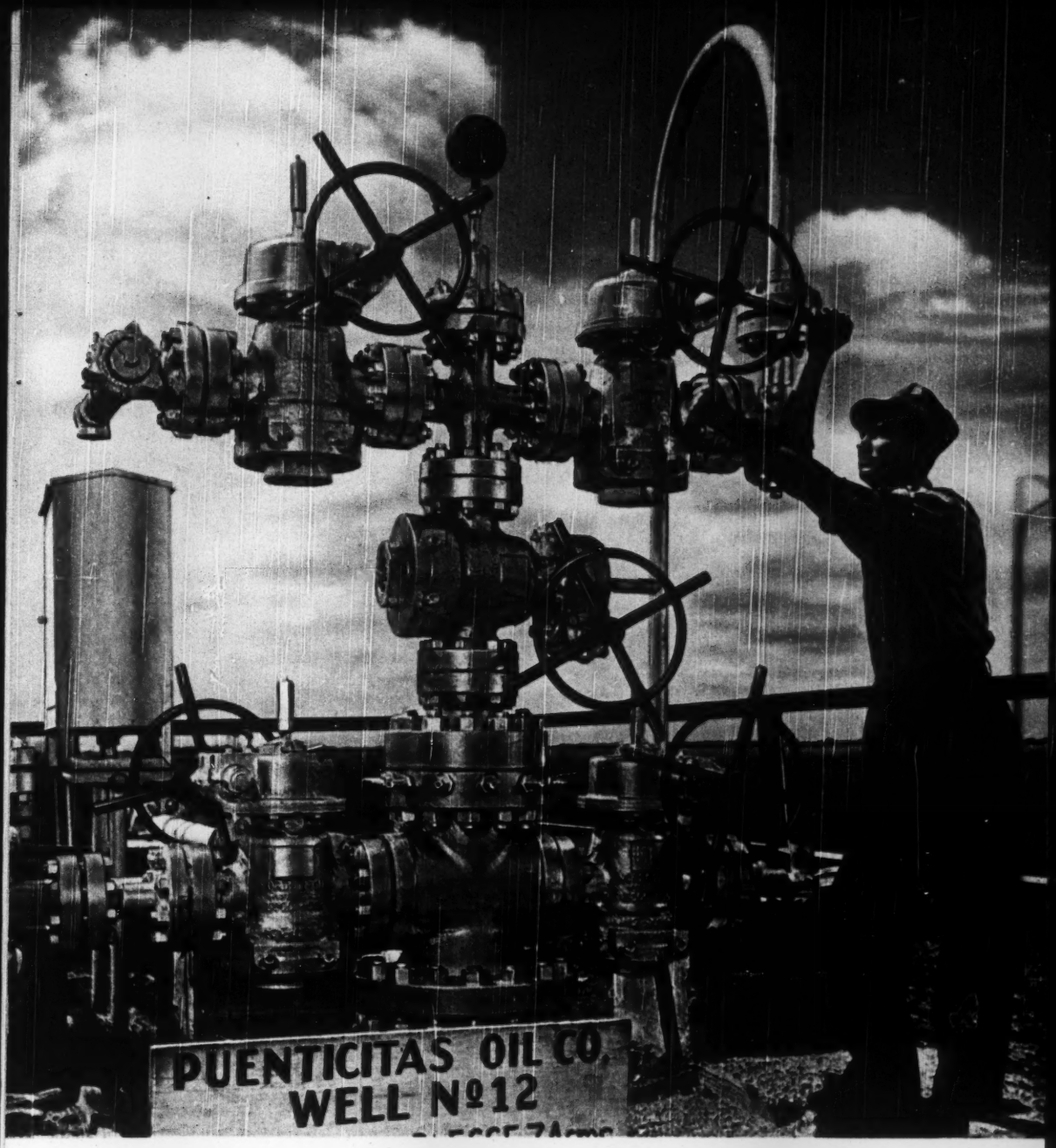
The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

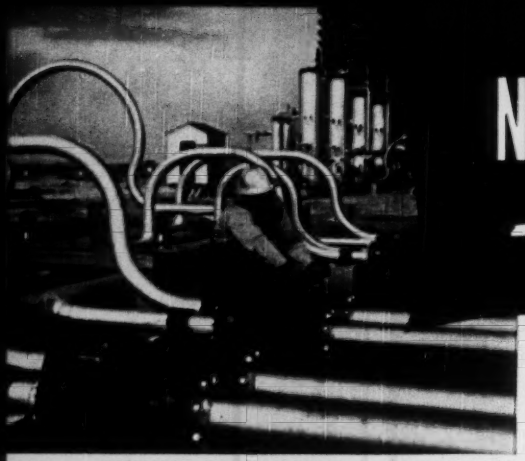


It's a pleasure to operate a Nordstrom valve. Smooth rotary movement instead of dragging action across seat rings insures easiest operation. An entire battery of Nordstroms can be opened or closed within a few minutes, in contrast to hours for some other types. There's no tug or toil to tighten or "break open" a Nordstrom, because the rotary, tapered plug is seated on lubricant, sealed by lubricant and jacked by lubricant.

Nordstrom

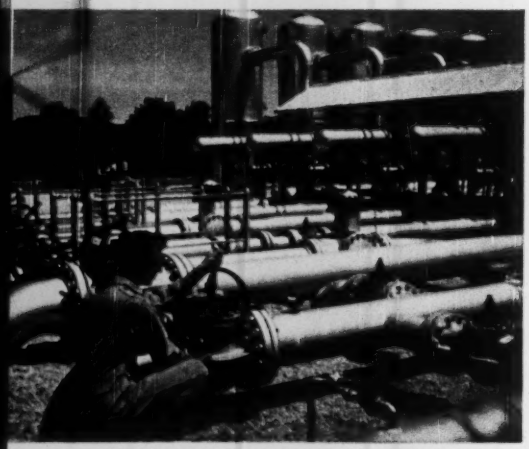
AUTOMATICALLY LUBRICATED VALVES

Nordstroms fit the Need —*Unsurpassed*



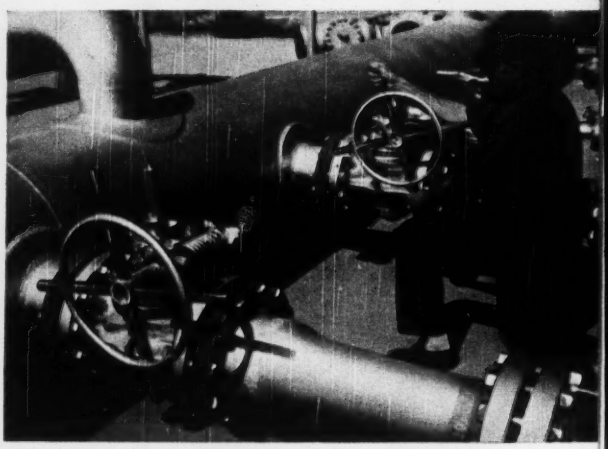
NORDSTROM VALVES IN FIELD PLANT COMPRESSOR LINE

FIELD PRODUCTION MANIFOLD, NORDSTROM EQUIPPED



NORDSTROM VALVES IN MAIN GAS COMPRESSOR STATION

NORDSTROM MUDLINE VALVES ON OFF-SHORE DRILLING BARGE

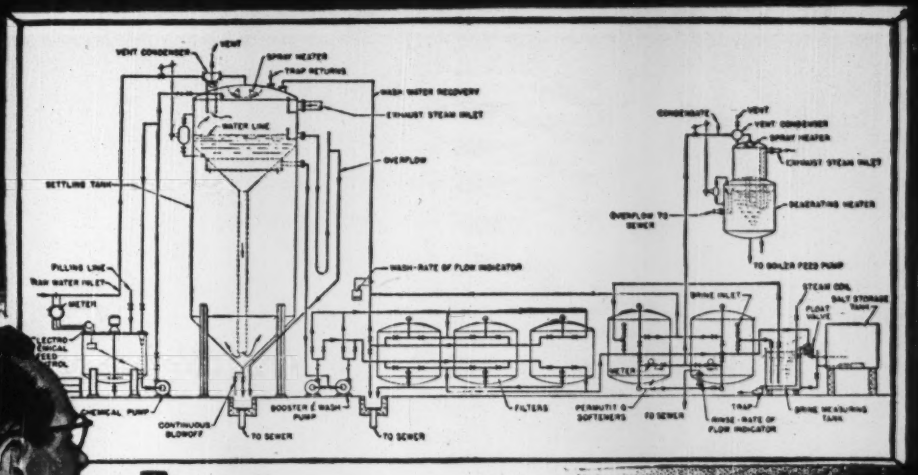


NORDSTROM VALVES ON CONNECTIONS TO MAIN GAS HEADER

Nordstrom Valve Division — ROCKWELL MANUFACTURING CO.
400 North Lexington Avenue, Pittsburgh 8, Pa.
District Offices in all principal cities

Nordstrom VALVES

Export — Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, New York



"...have you heard about Permutit's New Hot Zeolite Process?

"Permutit announced the process only a few months ago, but already we're putting it to good use in our plant. We think it's the best way of producing water that's low in alkalinity and silica . . . and with all hardness removed."

"Say, Ed, that's really something . . . getting an effluent of zero hardness from a hot lime soda softener! How's it possible?"

"Well, you see, Joe, they've developed a new mineral, Permutit Q. It's an ion exchanger that will withstand boiling water with a pH over 10, and it's not affected under operating conditions like that even after 1300 regeneration cycles."

"Tell me more! Is Permutit Q more economical than phosphate?"

"It is, and what's more, it reduces CO_2 in the steam. I'm really sold on this new process, because our chemical costs are lower, our effluent is lower in alkalinity and total solids, and we don't need acid feeding to prevent deposits in our high stage heaters and economizers."

"The more you tell me, Ed, the more I want to know. I think we could put this new hot zeolite process to work in our plant, too. How can I find out full information about it?"

"If you write to Permutit, they'll send you a new bulletin *full* of information. I have their address somewhere . . . oh yes! It's The Permutit Company, Dept. ME11, 330 West 42nd Street, New York 18, N. Y. Then there's the Permutit Company of Canada, Ltd. at 6975 Jeanne Mance Street, Montreal."

"Thanks for the tip, Ed. I'm sending them a letter today!"

Water Conditioning Headquarters for Over 37 Years

PERMUTIT

Wallace Barnes Springs

Bristol Connecticut

Here's what Safety-Circle means to your customers

✓All-Around Protection
✓Low Maintenance
✓Dependable Performance
The SAFETY-CIRCLE
The Allis-Chalmers Safety-Circle is the frame and ends of heavy cast iron that completely surround and protect the working parts of the Safety-Circle motor.
"Safety-Circle"

SAFETY-CIRCLE MOTORS are protected all around against those great motor killers—corrosion . . . distortion and friction.

Frames are of cast iron, which *inherently* resists corrosion. The natural strength of cast iron is supplemented by heavy ribbing and bracing . . . has high safety factor to maintain alignment and prevent distortion. Pre-lubricated bearings are packed and sealed at the factory . . . require no attention for years. And, end brackets are drip-proof at no extra cost.

Safety-Circle Motors are fully protected inside, too. Multiple dipped and multiple baked stator windings plus inter-phase insulation provide extra protection against electrical breakdowns.

CERTIFIED SERVICE

Another reason for supplying *Safety-Circle* motors on your equipment. There are 86 service shops to give your customers quick, factory approved parts and service in every major industrial area. Check coupon at right for details. And, when you do specify *Safety-Circle* motors, be sure to order matching Allis-Chalmers controls.

ALLIS-CHALMERS, 949A SO. 70 ST. MILWAUKEE, WIS.

Please send me:

Handy Guide for Electric Motors Bulletin 51B6052

Flange Motor Specifications Sheet 5157234

Safety-Circle Motors Bulletin 51B62108

Name _____

Title _____

Company _____

Street _____

City _____ State _____

A-3166

Safety-Circle is an Allis-Chalmers trademark.

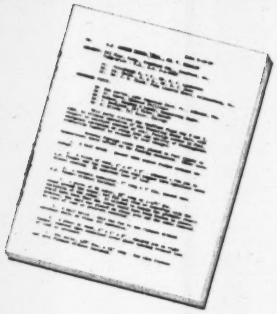
ALLIS-CHALMERS

SOLD AND APPLIED BY AUTHORIZED DEALERS, AND DISTRICT OFFICES THROUGHOUT U. S., SERVICED BY CERTIFIED A-C SERVICE SHOPS

YOU CAN BE SURE.. IF IT'S
Westinghouse

CENTRAFIRE
with Traveling Grate

A group examines some of the foreign material used in a punishing test of the feeding mechanism of a Centrafire with Traveling Grate. The original demonstration was conducted at the Westinghouse Plant at Trafford, Pa., on May 8 and 9, 1950. If you would like to see this test repeated, ask your nearby Westinghouse Steam Specialist for a showing.



YOURS FOR THE ASKING

Send for the complete report on the Centrafire with Traveling Grate test. Books are also available on either the Traveling Grate or Link-Grate Centrafire Stokers. Write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

COULD YOUR STOKER PASS THIS TEST?

The ability of the Centrafire with Traveling Grate to "take it" and continue to operate without loss of load under extreme conditions has been repeatedly demonstrated in tests like this one. Wet fuel and extraneous matter were handled without interfering with operation. Tests such as this prove that Centrafire feeders are virtually non-stallable. The unusual or large obstruction that causes difficulty is quickly and easily removed. Read these excerpts from the actual test report:

- **A half brick**—passed through center feeder without incident on both rotor and steam-jet operation.
- **Blocks of wood**—of two sizes, both sheared pins in feeder, but were removed without loss of load or pressure.
- **Ceramic Insulator**—passed through feeder without incident.
- **A piece of BX cable**—3½ feet long—wound around rotor, but did not stop or interfere with operation of the rotor.
- **Two bolts**—⅜″ x 5½″—fed through feeders and into furnace without incident.
- **Steel cable**—forty-six inches of ½″, fed through feeder endwise, worked through and into furnace without incident.
- **Market coal**—½″ x 0″, bone dry, was wet down at the coal conveyor and successfully fed into furnace without incident.
- **Extremely wet coal**—with continuous stream of water running out of all feeders—was fed with no adverse effect. Some wet coal accumulated on the feeder sills in the furnace but was easily removed with poker.

The outstanding performance of the Centrafire with Traveling Grate stems from features that are built in—not added as accessories. All moving elements are hydraulically operated by one turbine or motor-driven oil pump. This assures infinite flexibility through the complete range of operation—synchronizes coal feed and grate speed. The Centrafire's range extends upwards of 300,000 lbs. of steam per hour. It will pay you well to get the full Centrafire Story.

J-50513

Norblo

Dust and Fume Collection... Engineered, Efficient, Economical

Shown above are three distinct types of modern dust and fume collecting equipment — Centrifugal, Hydraulic, Bag types. These three types used in combinations provide the better, more economical and more efficient solutions of a wide range of dust and fume control now demanded by modern large scale industries in the smelting, rock products, chemical, milling and processing fields.

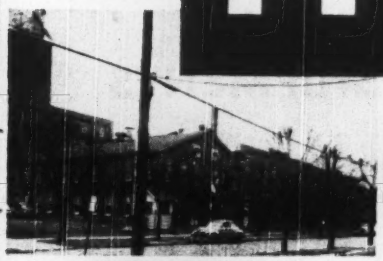
Though Norblo equipment of all three types is available in a wide range of c.f.m. capacities, Norblo is outstanding for larger, heavy duty installations.

For detailed information on each of the types shown above ask for Bulletin No. 104-2 covering centrifugal and hydraulic, or Bulletin 164-2 for automatic bag type collectors. Also available, Cement Air Cooling Bulletin No. 165-1, and complete catalog of fans No. 1002-1.

THE NORTHERN BLOWER COMPANY

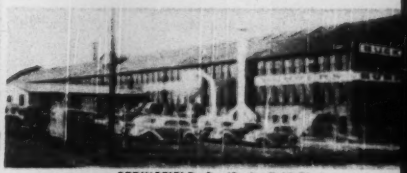
6421 BARBERTON AVE. • CLEVELAND 2, OHIO

14 AUTO-LITE PLANTS
DETROIT STOKER EQUIPPED



TOLEDO (Ketcham Ave. Plant)
3 DETROIT STOKERS

BAY CITY, MICH. (Bay Mfg. Div.)
3 DETROIT STOKERS



SPRINGFIELD, O. (Springfield Div.)
1 DETROIT STOKER

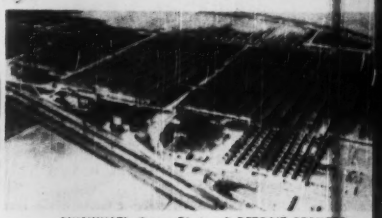
PORT HURON, MICH. (Wire & Cable Div.) 4 DETROIT STOKERS

WOODSTOCK, ILL. (Die Casting Div.)
2 DETROIT STOKERS

FOSTORIA, O. (Spark Plug Div.)
3 DETROIT STOKERS

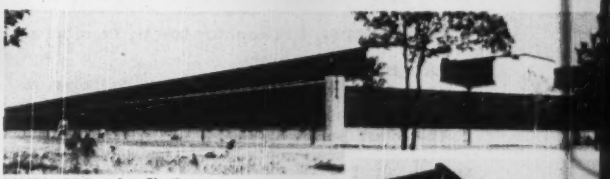
SARNIA, ONT. (Electric Auto-Lite Ltd.) 4 DETROIT STOKERS

SHARONVILLE, O. (Bumper Div.)
3 DETROIT STOKERS



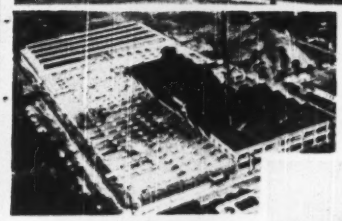
CINCINNATI (Lamp Div.)—2 DETROIT STOKERS

FOSTORIA, O. (Foundry Div.)
2 DETROIT STOKERS



TOLEDO (Stickney Ave. Plant)
2 DETROIT STOKERS

TOLEDO (Champlain Street Plant)—3 DETROIT STOKERS



LA CROSSE, WIS. (Instrument & Gauge Div.) 3 DETROIT STOKERS

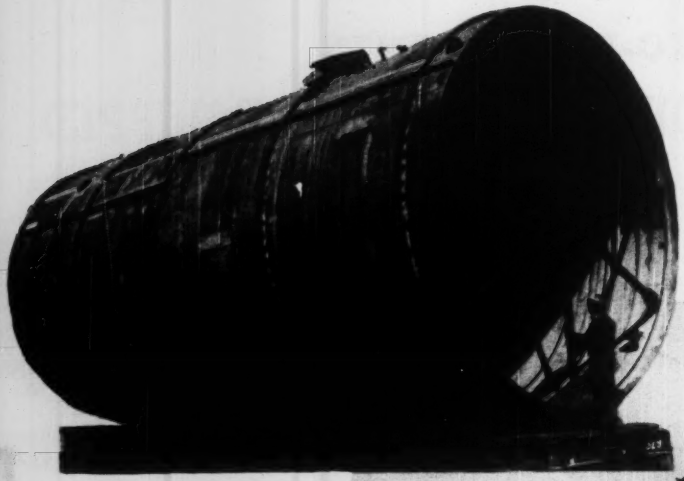
VINCENNES, IND. (Auto-Lite Battery Corp.)—1 DETROIT STOKER

DETROIT STOKERS

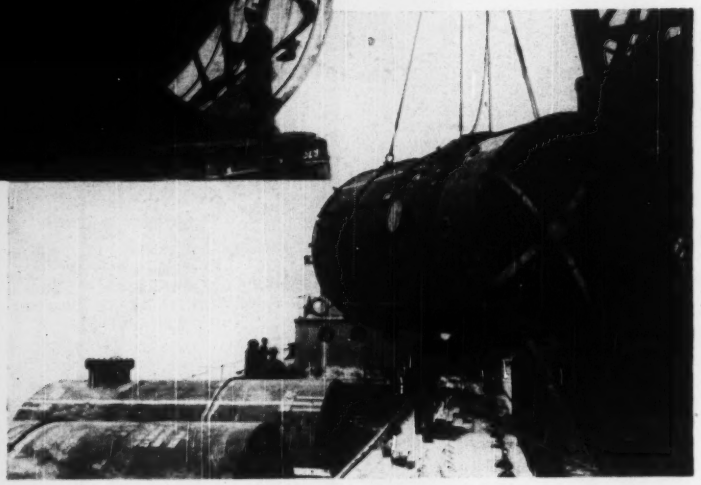
36 DETROIT STOKERS SINCE 1929 . . . FOR
THE ELECTRIC AUTO-LITE COMPANY

Overwhelming Evidence of Satisfactory Performance

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN



DIRECT WATER OR RAIL SHIPMENTS



BUILDERS OF HEAVY EQUIPMENT

Sections of a synthetic-crude column are shown being loaded at one of the deep water piers of the company for shipment to Perth Amboy, New Jersey. This 90-foot high column was a part of recent production at Newport News that has included both a hot and a cold catalyst hopper, fractionator tower, reactor, and other items for the chemical and petroleum industries.

The wide range of large facilities in the 225-acre Newport News plant are particularly suited for the production of heavy equipment. Constant investigation keeps the plant abreast of the developments in manual and automatic welding methods. Modern radiographing instruments and large stress-relieving ovens are included in the plant facilities. Your inquiries are invited.

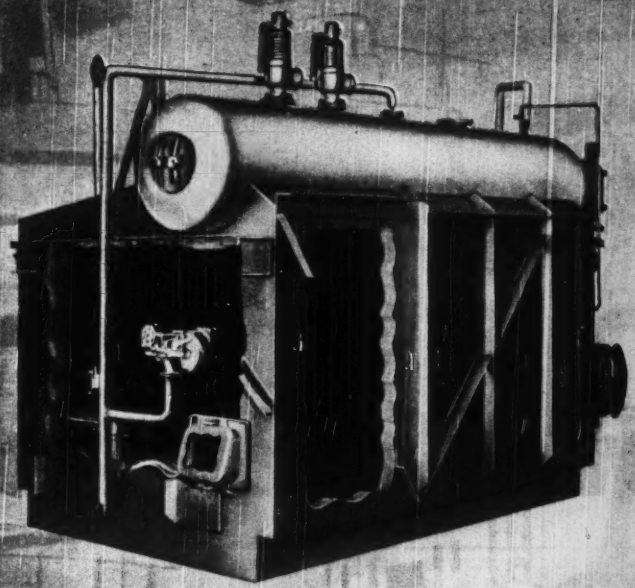
NEWPORT NEWS

SHIPBUILDING AND DRYDOCK CO.

NEWPORT NEWS VIRGINIA

"Package" with a "Pedigree"

Foster Wheeler—first in the design and fabrication of Water-tube Package Steam Generators



Units up to 30,000 lb per hr for both small and medium size plants

Foster Wheeler was building portable Water-tube Package Steam Generators as far back as 1940. Today, mounting orders from leading industries throughout the country testify to the fact that Foster Wheeler Package Steam Generators are "doing the job." These versatile units, which assure higher efficiency and real economy in the cost of steam production, reflect the broad background of Foster Wheeler industrial and central station experience. They are easily installed by means of a few service connections and are adaptable to various fuel and firing arrangements.

Let us show you how to modernize your plant the Foster Wheeler way at relatively low cost. For further information, write . . .

FOSTER WHEELER CORPORATION **165 BROADWAY, NEW YORK 6, N. Y.**

FOSTER WHEELER

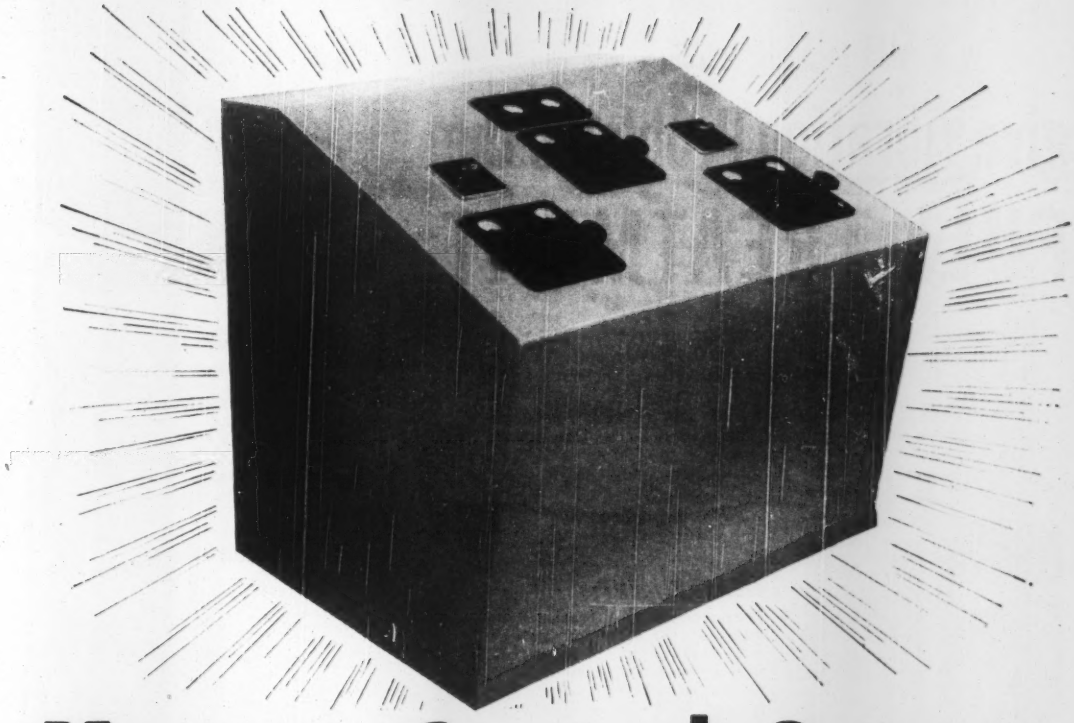
Announcing the new

REPUBLIC Electronic

See It!
Operate It!

VISIT BOOTH NO. 6
NEW YORK
POWER EXPOSITION
NOVEMBER 27 – DECEMBER 2

You are cordially invited to visit Booth No. 6 to see—to operate—to inspect the new Electronic TELEMASTER Control which will be on view for the first time. Our engineers will be available to explain its many unusual features. The complete line of Republic instruments and controls will also be included in the exhibit.



Master Control System

"TELEMASTER"

The new Republic Electronic TELEMASTER Control represents a major advance in the field of automatic control. The TELEMASTER will remotely reproduce, instantly and accurately, a position or a force — perform arithmetical and algebraic calculations—and can be used for multiple operations. Essentially it performs the function of a mechanical link through electrical and electronic means. It is applicable to all types of combustion and process control.

In plants where distances between operating units are great, the lags inherent in the compression effect of a pneumatic master system are appreciable. This effect is frequently sufficient to prevent realization of the full benefits of automatic control. The Republic Electronic TELEMASTER Control has no inherent lag, regardless of distance. This means that centralization of operations can be achieved without any sacrifice of control performance. *Full details sent upon request.*

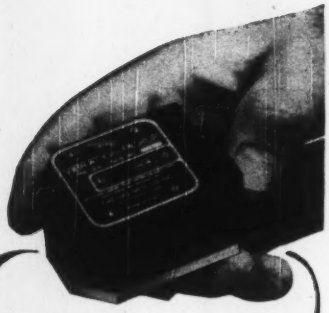
REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

With **MB** products, of course, you can

give Vibration Problems the FULL TREATMENT

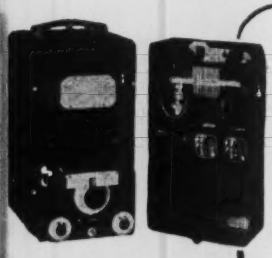
One thing is sure about your vibration problem. The more "tools" you have to deal with it, the faster you get your answers, the better the results you achieve, the more work you save.

And here is the equipment for the job. These MB products can help you in the four essential phases of vibration control work.



DETECTION:

The MB Vibration Pickup has practically no lower limit on amplitudes to which it responds. It stands up in heavy duty work as well. It converts vibratory motions to electrical voltages which can be measured by the meter.



MEASUREMENT:

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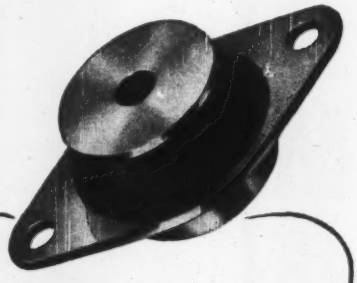

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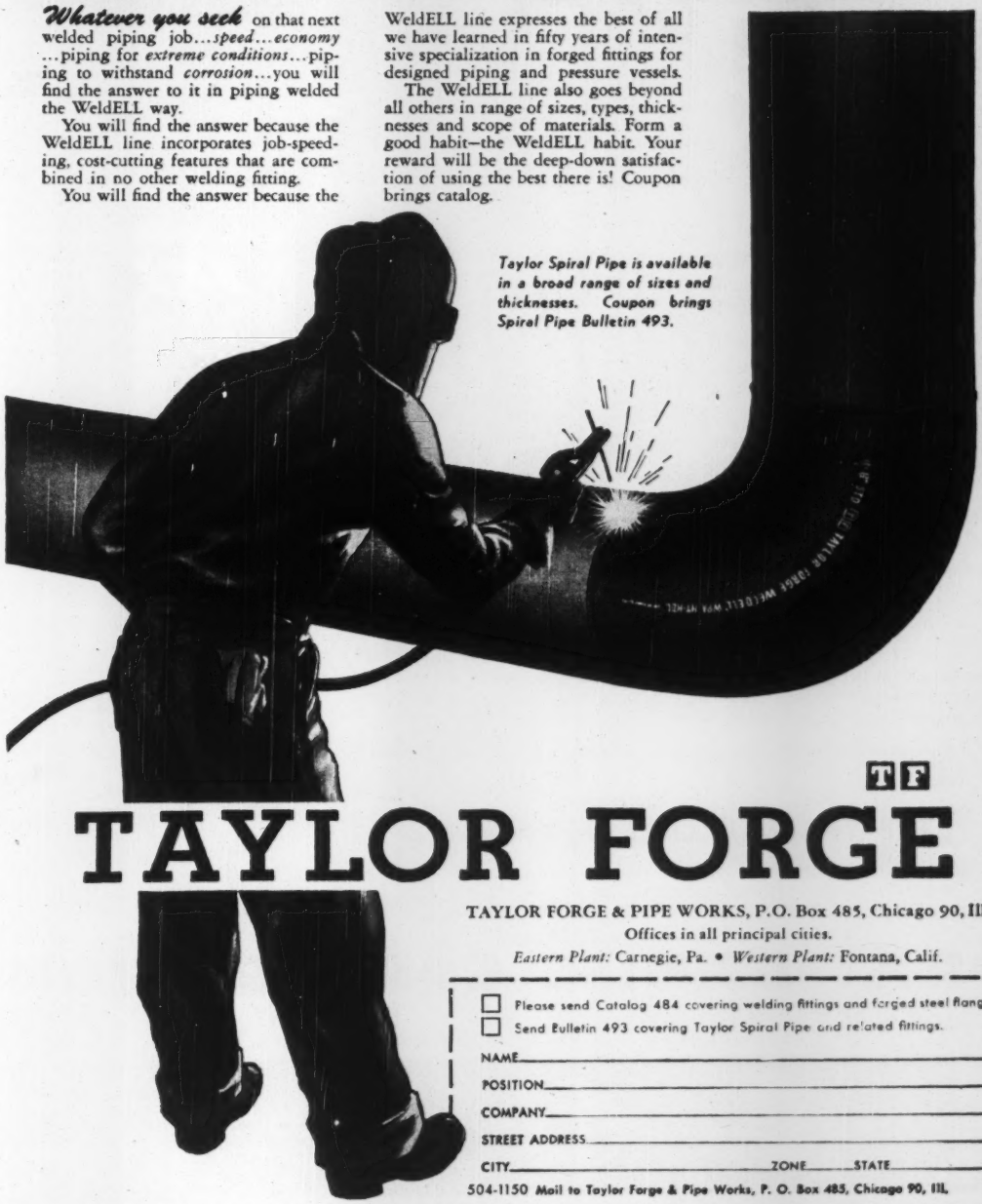

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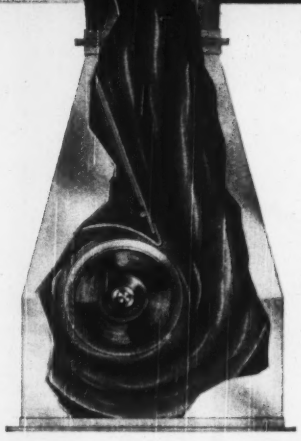

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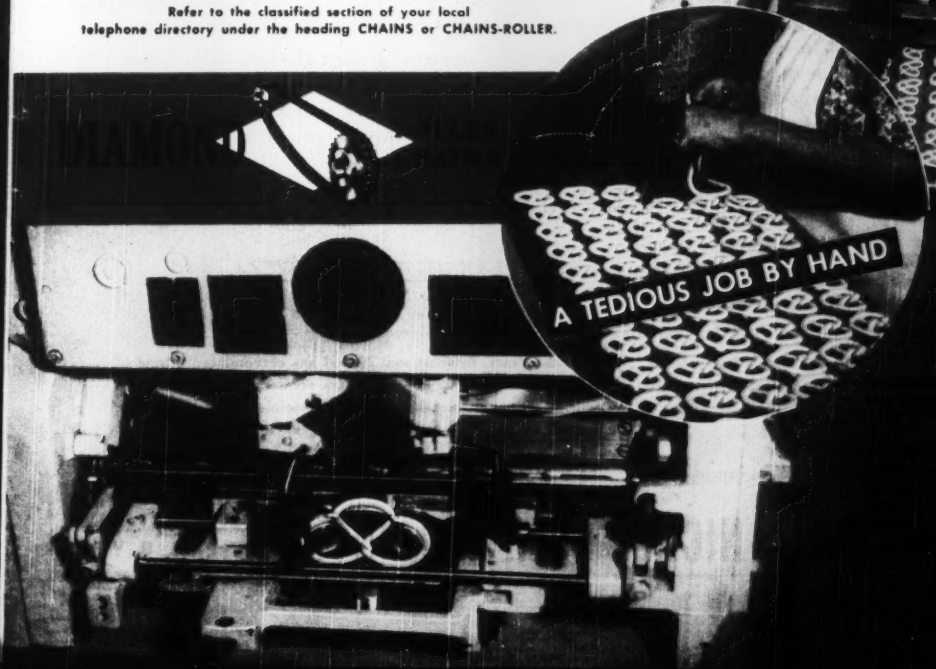

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Reduction of Area	15-30%
Coefficient of Expansion	0,0000091 per degree F.
Specific Gravity	8.70-8.90
Weight per cubic foot	540-550 lbs.
Brinell Hardness	75-100 (1000 kg. load)
Shrinkage (inches per foot)	3/16
Machinability	Readily machined by all methods

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 11

Contents for November, 1950

FURNACE BRAZING OF MACHINE PARTS—PART I	*H. M. Webber*	863
AN ENGINEERING APPROACH TO STABILIZED PROSPERITY	*E. G. Nourse*	870
ELECTROSTATIC COLLECTION OF FLY ASH	*H. J. White, L. M. Roberts, and C. W. Hedberg*	873
THE HUEY GAS TURBINE	*C. C. Willis and E. C. Goldsworth*	881
CONSIDERATIONS IN DESIGNING TOOLS FOR POWDER METALLURGY	*I. J. Donahue*	886
THE RETURN ON INVESTMENT	*H. J. Lang*	890
WHAT PROGRAM FOR ECPD?	*H. S. Rogers*	895
STANDARDS FOR CITIZENSHIP	*A. T. Vanderbilt*	897

EDITORIAL	861	REVIEWS OF BOOKS	925
BRIEFING THE RECORD	901	ASME BOILER CODE	929
ASME TECHNICAL DIGEST	912	ENGINEERING PROFESSION, NEWS, NOTES	930
CONTENTS OF ASME TRANSACTIONS	918	ASME NEWS	938
COMMENTS ON PAPERS	919	ASME JUNIOR FORUM	946
ENGINEERING SOCIETIES PERSONNEL SERVICE	948		

BUYER'S CATALOG GUIDE	41	CLASSIFIED ADS	114
POWER SHOW GUIDE	87	CONSULTANTS	118
ADVERTISERS	120		

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Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents; to nonmembers one year $7.00, single copy 75 cents. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . .

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MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

Three-Coat Mica-Base Paint System Doubles Transformer Tank Life

(In the accompanying photograph transformer tanks are shown emerging from infrared drying oven after a zinc chromate-iron oxide primer or first coat has been applied. The second coat, which is the key to the finish, is composed of a vehicle of modified phenolic and alkyd resins and a pigment of selected mica flakes which overlap each other producing a "shingle-roof" effect that wards off moisture and oxygen. The final coat which consists of resins and pigments provides further protection, good appearance, and screens out the sun's ultraviolet rays. Westinghouse Electric Corporation's Transformer Division at Sharon, Pa., developed the new method.)

VOLUME 72
No. 11

MECHANICAL ENGINEERING

NOVEMBER
1950

GEORGE A. STETSON, *Editor*

ASME Aids Progress

IN the first of his Godkin Lectures for 1949 delivered at Harvard University and recently published in a little book called "The American Century," Ralph E. Flanders, past-president and Honorary Member ASME, after describing the standard of living and working hours and conditions that prevailed in this country when he was an apprentice in 1896, asked why the wage earner of his childhood "worked harder and longer and enjoyed less than the wage earner of today." The answer he gave was simple but significant: "The advantages which the present-day workman enjoys," he said, "do not come from harder work or longer hours. They come from new methods of manufacture, new productive machinery, new materials, and new products. They come by these means because billions upon billions of dollars were put into industrial plants by investors. This is the way and the only way in which the standard of living of our people has been raised or can be raised."

In this simplified generalization of the source of material progress in the United States, Senator Flanders highlighted the principal area in which the function and responsibility of the engineer are to be found. It is the area in which engineers of the nineteenth century had their most substantial interest when they organized The American Society of Mechanical Engineers.

At a time when the national welfare, the rights and dignity of the individual, and the free institutions essential to the American way of life are at stake, it is reassuring to have evidence of the virility and growth of the technology upon which survival and advancement depend, not solely but importantly. We are conscious that creative technology, by usefully applying the discoveries of science, by instituting high rates of productivity, and by exercising superior managerial skills, saved western civilization from destruction in the recent World War. We are also conscious that one of the most potent safeguards against totalitarian aggression is an advancing standard of living ever more widely extended throughout our own nation and the rest of the world. We realize that technology is an instrument that can be used against us by those who wish to destroy us; but we are confident that technology advances most rapidly and is most effective among free men under free institutions. Thus, no matter how widely diversified the activities of engineers and engineering societies become, or how much effort they may expend on matters relating to their own economic status, or the many segments of the general welfare in which they may find opportunities for service, they must not neglect the core of their duties, the advancement and dissemination of their particular fund of technical knowledge. It is by such means that ASME aids most significantly the progress and welfare of the nation.

An engineering society is but one of several organized means of advancing and disseminating knowledge. It derives its strength and effectiveness from its members, acting as individuals, who are engaged in numerous and diverse fields of practice at practically every functional level, and from groups of its members which bring together an assortment of skills and experience in co-ordinating special areas of knowledge and practice, thus achieving what the individual alone lacks ability and opportunity to do.

The general patterns which appear in examining the process by which engineering knowledge originates, is shared, and is widely disseminated, are familiar. Advancement originates in research and in the experiences or practices of individuals, organizations, or groups; it is made public in technical papers or reports presented and discussed at meetings; and it is disseminated through publication. As knowledge so originated and made public is put into use and is co-ordinated with other knowledge, new and old, it finds its way into textbooks and handbooks and may be incorporated into codes of practice and into standards. It is the function of the engineering society to encourage and participate in every step of this process; and to this end the ASME is organized. Starting with its professional divisions, its technical committees, and its research activities, it uncovers and selects the contributions engineers have to make as a result of their researches and practice; it affords a forum for presentation and discussion; it publishes results in periodical or other form; and it incorporates some of the knowledge and experience into codes and standards. Thus advances in mechanical engineering, which may and usually do start as an individual's paper on a specific subject, become public property, are incorporated widely into engineering practice, and frequently fertilize related and sometimes quite foreign fields of technological progress.

Properly to perform its function in stimulating the growth and dissemination of technical knowledge in its special field, an engineering society must organize its membership and administer its affairs so that it is alert to what is going on in its field; it must encourage its members and others to report their significant researches and experiences; it must retain a flexibility of attitude and organization to cope with changing conditions and new ideas; it must co-operate with other engineering societies, educational institutions, and

external groups whose interests may become involved; it must develop new areas of needed knowledge, if such development is not being carried on by others, and coordinate those developments, if they are in progress; and it must have a liberal policy of publication of results through its own media and by encouraging publication by others.

How well ASME performs these numerous functions and to what extent it has contributed significantly to the growth and dissemination of mechanical engineering during the past year cannot be stated solely in quantitative or comparative terms. It is possible to assemble statistics which involve quantity but not quality of product. A list of papers presented, a list of papers published, a record of codes, standards, and miscellaneous books and pamphlets, could be assembled. The opinions of members could be solicited, and the reports of committees could be studied. But no comprehensive or satisfying estimate of the technological importance of the year's work would result that time itself would not modify or invalidate. The principal value of any attempt at summary is inspirational, a feeling on the part of the individual member that perhaps after all something has been accomplished that was worth while, that it was a greater and more important effect that he had realized, and that he himself might add his bit in the coming year, and by giving more for the benefit of others, get more for himself in return.

One place to start is with MECHANICAL ENGINEERING, because every ASME member gets a copy every month. Examination of a single issue is not too revealing, but from an examination of twelve consecutive issues patterns begin to emerge. One must remember that what is noted in MECHANICAL ENGINEERING is fairly representative of what ASME members who are willing to work at it are interested in.

Taking, then, the twelve issues of MECHANICAL ENGINEERING published during the 1949–1950 fiscal year, a statistical analysis will show about 100 full-length articles of which about two thirds are strictly technical; more than 200 items covered by the "Briefing the Record" section; nearly 300 ASME papers abstracted in the "ASME Technical Digest" section; about 40 major book reviews and hundreds of book notes; more than 100 notices and reports of engineering meetings, ASME and others; and some thirty-odd references to ASME codes and standards. This is a purely "volumetric" measure of a year's offering in a single ASME periodical publication, but one which every member has an opportunity to examine month by month. To read all the material this represented no one person would do, but the experience would convince any skeptic that ASME is making its contribution to the technical literature of its field.

If we examine the issues of the *Journal of Applied Mechanics* and the ASME Transactions which present in complete form and with discussion many of the ASME papers that are noted in abstract form in MECHANICAL ENGINEERING, we shall find that during the year 1949–1950 the *Journal* contained 56 technical papers and the Transactions 125. In addition to these papers, the *Journal* printed 26 reviews of books in the field of applied mechanics. Surely these 181 papers, selected from among more than twice that number available as a result of the technical meeting activities of the Society because they appeared to have some claim to permanent reference value, represent a significant contribution by the Society to the growth and dissemination of engineering knowledge and aid the progress of the nation.

Suppose an ASME member had resolved to attend every meeting of national character offered by the Society and its professional divisions during the year 1949–1950. Had he done so he would have spent 39 working days, without time necessary for travel, at 11 such meetings and conferences. He would have had an opportunity to attend 202 technical sessions and listen to the presentation and discussion of 498 papers. And he would have come in contact with some 10,500 mechanical engineers in attendance at these meetings. Surely such an individual could not look back on the experience of such a year without realizing that his Society was expending a tremendous amount of energy and effort in the advancement and dissemination of mechanical-engineering knowledge. And if he were to review the work of the 350 committees and subcommittees of the Society engaged in standardization activities and the 493 pages of new standards published during the year, he would be conscious of the fact that ultimately much of this advancement of technology is incorporated into American standards.

The ASME will hold its seventy-first Annual Meeting at the Hotel Statler in New York from November 26 to December 1, and in conjunction therewith the 1950 Power Show will be in progress at the Grand Central Palace. Attendance at these events will afford overwhelming evidence of the virility of the Society as an organization of loyal and competent engineers who are working day by day for a better and stronger nation that is determined to keep ahead of all other nations in the advancement of technology and applied science, and to share the know-how they develop with the rest of the world. Every area of technical development in the field of mechanical engineering will be included in one form or another. Those broader aspects of engineering service to society that are represented in education, in civic-mindedness, in co-operation with other groups at home and overseas, and in the continued development of engineers individually as men of "full habit of mind," will also receive attention. Nor will the internal affairs of the Society as a corporate body be neglected. And of course the social events, which add so much to enjoyment and relaxation and promote good fellowship, will be provided. It is at such a meeting that the observer can see for himself what technical progress is under way in the field of mechanical engineering and can sense the manner in which engineers are continually developing as well-balanced and useful citizens. There is no more profitable way of having one's convictions strengthened that ASME, through the individual and organized efforts of its members, is advancing its own field of specialization and thus aiding the progress of our American way of life.

FURNACE BRAZING *of* MACHINE PARTS

Part 1—Where, Why, and How Electric-Furnace Brazing Is Being Used in 1950

By H. M. WEBBER

INDUSTRIAL HEATING DIVISIONS, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

A VARIETY of brazing methods, classified according to the means of heating, are now well known, including torch brazing, dip brazing, induction brazing, salt-bath brazing, and furnace brazing. Castings, forgings, and parts machined from solid stock sometimes can be redesigned and fabricated from stampings, screw-machine parts, and pieces of tubing, the object being to minimize machining operations, speed production cycles, and reduce costs.

The early history of furnace brazing includes its accidental discovery in 1907 in the General Electric Research Laboratory, following which, in 1912, the first application of the process was made. This was in the manufacture of rivet-type tungsten contacts for automotive ignition systems, as illustrated in Fig. 1. The problem of bonding tiny tungsten disks to steel shanks was satisfactorily solved by placing a wafer of copper foil between the two parts and passing them through hydrogen-atmosphere electric furnaces. Graphite boats were utilized, with drilled holes to index the parts and serve as trays for carrying the assemblies through the furnaces. It is interesting to note that the same type of contacts, as well as a variety of others, are being furnace-brazed today in the same manner, excepting, in most cases, more modern-type batch and continuous furnaces are used.

Other early applications included steel golf-club shafts, steam-turbine diaphragm nozzle rings, and subassemblies for electric refrigerators. Following these uses, the process has expanded into other fields for fabricating subassemblies for business machines, sewing machines, automobiles, tractors, airplanes, ships, and so on.

FUNDAMENTALS

In order that the discussions on typical applications and other general principles can be understood to best advantage, a few basic fundamentals will be discussed (1).[1]

If two clean glass plates are held closely together in water, as illustrated at A in Fig 2, the water will wet the glass and rise in a column between the plates—the closer the plates, the higher the column. If glass plates are immersed in mercury, however, no wetting takes place and a depressed column will appear, as indicated at B in Fig. 2. But water and mercury behave differently with different materials. For example, if amalgamated-zinc plates are immersed in mercury, wetting takes place as shown at A, while if paraffin plates are immersed in water, no wetting takes place, with results as shown at B. The point is that if it is desired to have a liquid creep between two surfaces, the first thing necessary is wetting; and this can be likened to the flow of molten brazing metal through joints in assemblies passing through a brazing furnace, where the wetting action and capillary attraction play prominent parts.

This effect in the furnace-brazing operation can be better understood by referring to Fig. 3 in which a furnace-brazed track body for tanks is illustrated at the center. The assem-

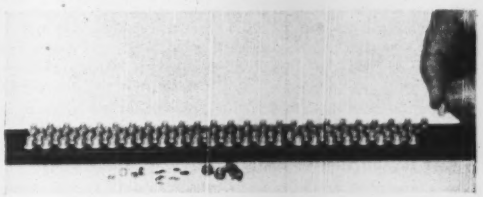

FIG. 1 TUNGSTEN CONTACTS FOR AUTOMOBILE IGNITION SYSTEM

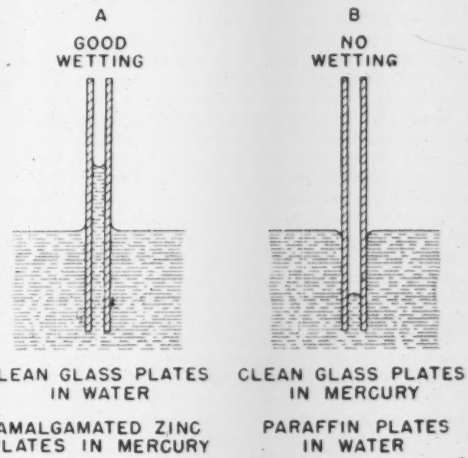

FIG. 2 WETTING AND CAPILLARY ATTRACTION WORK HAND-IN-HAND TO DRAW LIQUIDS BETWEEN CLOSELY HELD PLATES, AS AT A; NO WETTING REPELS THEM, AS AT B

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

NOTE: This is the first of two installments dealing with the various phases of furnace brazing.

Contributed by the Machine Design Division for presentation at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

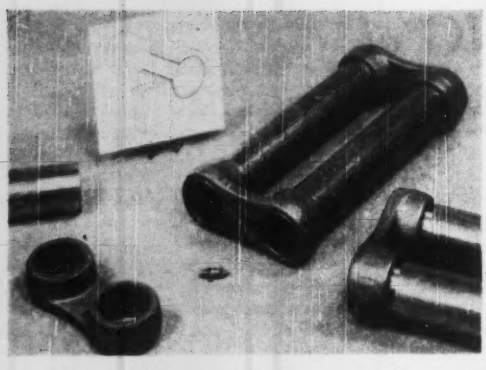

FIG. 3 TRACK BODY FOR TANK (*center*) HAS HALF-RINGS OF COPPER WIRE PREPLACED AT JOINTS PRIOR TO FURNACE BRAZING (*right*)

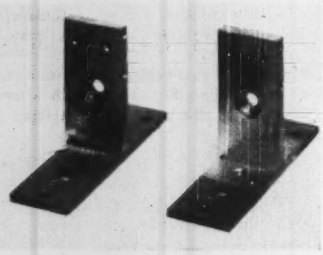

FIG. 4 COPPER DID NOT WET SILICON STEEL (*left*) UNTIL FLUX WAS USED IN ADDITION TO THE PROTECTIVE ATMOSPHERE (*right*)

blies to be furnace-brazed generally have brazing metal preplaced at the joints. At the right in Fig. 3, where the two steel tubes enter the forging, half-rings of copper wire are preplaced at the joints to serve as the brazing metal. When brazing with copper, which melts at 1981 F, the furnace temperature is about 2050 F. The assemblies pass into this high heat in a protective atmosphere which serves the purpose of a flux to assure good wetting of the copper on the steel when the copper melts. The copper is then drawn throughout the joints by capillary attraction as shown in the sketch in Fig. 3, and appears at the opposite extremities of the joints as a thin copper coloring on the surfaces of the parts, giving visual indication that a bond has been obtained. Strong alloys with high strength are developed within the bond, as will be discussed later. The assemblies then pass to a controlled-atmosphere water-jacketed cooling chamber, where their temperature is reduced to 300 F or below so that they can be brought out into the air without discoloring. Thus the assemblies emerge clean and bright, ready for subsequent operations.

For those who do not fully appreciate the significance of the wetting action, an example which will clarify it is shown in Fig. 4. The brackets illustrated are for industrial control devices, and the two components are held together by screws coming up through the bottom plate. The one at the left was furnace-brazed in the conventional manner by applying a straight length of copper wire along the joint, but when the assembly came from the furnace, the copper had not spread smoothly on the surfaces and crept through the joint, as expected. Instead, it left a pebbly deposit on the surface of the lower part, as seen near the common pin in the photograph. Investigation revealed that the lower member was 3.5 per cent silicon steel. This had not previously been brought out, and since it is known that silicon, as well as numerous other alloying elements, oxidizes even in most protective atmospheres, a flux was dictated in order to dissolve the oxide or prevent its formation, to assure good wetting. The assembly at the right was prepared with a small quantity of flux applied on the lower member, and it was then brazed in conventional fashion. After brazing, the copper was found to be distributed in a thin film over the surfaces of the parts (visible in Fig. 4) with a good bond throughout the joint. This need for flux occurs only in special instances in furnace-brazing work. Most applications are on low-carbon steel, using copper as the brazing metal, for which flux is not required.

A photomicrograph of a typical copper-brazed bond between two pieces of low-carbon steel is shown in Fig. 5. The darkened grains at the interfaces indicate that copper has alloyed with the steel, and there is also evidence of penetration of the copper along the grain boundaries. Both of these actions give the copper a good toe hold into the steel. The lightest portion within the bond is copper which has probably absorbed some iron, which materially increases the strength of copper. The dark globules within this white band are probably some of the iron-rich phase which has precipitated out upon cooling, since copper cannot hold as much iron when cold as when hot. At

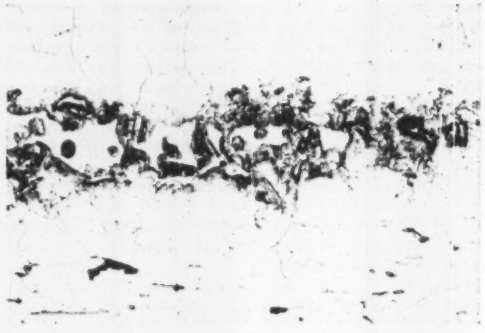

FIG. 5 PHOTOMICROGRAPH OF TYPICAL COPPER-BRAZED BOND BETWEEN TWO PIECES OF LOW-CARBON STEEL; MAGNIFICATION 250×

points of intimate contact between the steel surfaces, such as at the right in Fig. 5, the grains of the steel often grow together with a knitting action across the joints. All of these various effects add up to give much stronger bonds than would be obtained with only cast copper within the joints.

TYPICAL APPLICATIONS

A good idea of the possible uses of electric-furnace brazing can be obtained by seeing what manufacturers in the stove, automotive, refrigeration, business-machine, and other industries, have done with it. They will be grouped in so far as possible, according to former methods of manufacture.

Formerly Cast. Burners for stoves, water heaters, space heaters, and the like have commonly been made of cast iron. Fig. 6 shows a water-heater burner made of steel stampings crimped and spot-welded, then furnace-brazed, this being typical of a variety of similar burners manufactured for the products mentioned. Considerable material is saved through reductions in weight. This has secondary benefits in the form of easier handling of the equipment and lower freight costs. Operating

efficiency is improved by better contours and smoother inner surfaces of Venturis and burners. Some machining operations have been eliminated. Over-all costs are appreciably lower.

A doughnut-shaped piece of copper foil laid over the top of the burner brazes the ports to the top shell, as well as the inner and outer crimped seams. Clips over the top Venturi seam and a copper wire inside the Venturi supply brazing metal to those joints.

Cast pulleys, as shown in Fig. 7(A) and used for automobile water pumps, generators, etc., have been widely replaced by fabricated pulleys of numerous types. Advantages claimed often include lighter weight, reduced machining, better balance, and lower cost. Fig. 7 illustrates how a typical pulley is made by furnace-brazing. First, the two components shown at B, the hub and shell, are assembled with a copper-wire ring

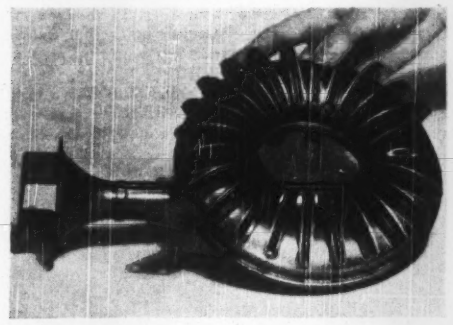

FIG. 6 FURNACE-BRAZED BURNER FOR WATER HEATER

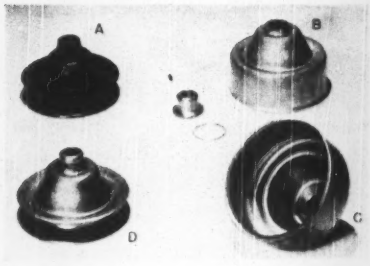

FIG. 7 AUTOMOTIVE PULLEYS

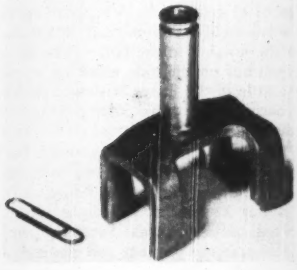

FIG. 8 SHIFTER YOKE FOR AUTOMOTIVE TRANSMISSION

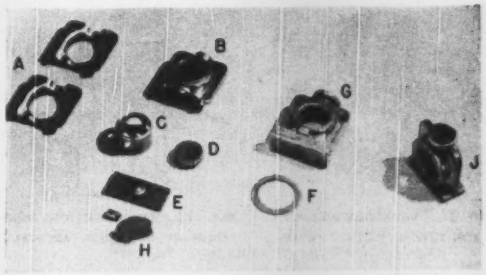

FIG. 9 ROCKER-ARM SHAFT BRACKET FOR AIRCRAFT ENGINE

FIG. 10 BRASS STUFFING-BOX ASSEMBLY

at the joint, as shown at C, and then the assembly is passed through the brazing furnace. Following this, the side wall of the shell is spun to have a V groove, as shown at D. This operation imparts stiffness by cold-working, and assures good concentricity and balance.

The furnace-brazed shifter yoke for an automobile transmission, shown in Fig. 8, was formerly a pearlitic malleable-iron casting. The fabricated assembly has greater strength and smaller size, making it possible to design a new, more compact, transmission. Elimination of machining operations has contributed to lower over-all cost. The stamping is made of SAE-1040 black hot-rolled steel strip, and the pin from low-carbon screw-machine stock.

A rocker-arm shaft bracket, for aircraft engines, formerly cast, now furnace-brazed, is shown in Fig. 9. Now made of seven stamped parts, machine work has been cut 50 per cent, weight decreased 25 per cent, and cost reduced 20 per cent. The construction includes spot welding of the two stampings, shown at the extreme left at A, to form the body B. Into the body is pressed a sleeve C, an embossed disk D, two embossed plates E to form a base, and then a washer F is pressed over the sleeve. The assembly as prepared for furnace brazing is shown at G, with the copper slug and copper powder H applied at the joints. The finished assembly is shown at the right at J. This is a good example of ingenuity in redesigning a cast part to utilize fabricated construction.

The brass stuffing-box assembly, Fig. 10, now furnace-brazed as shown at the right, was formerly cast and machined, but because of porosity, rejections were excessively high. Now that it is made of two parts machined from brass bar stock, shown at the left, with a silver-brazing-alloy ring and flux preplaced at the joint, this difficulty has been completely overcome and the over-all cost is lower. In this instance the parts are fluxed at the time of the assembling operation, to assure wetting of the brass by the silver-brazing alloy. After furnace-brazing, cleaning and bright-dipping operations are utilized to remove flux and zinc-oxide deposits from the surfaces of the parts. A furnace-brazed assembly is shown after receiving the cleaning operations, and after a final machining and threading

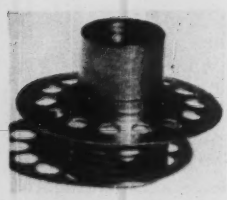

FIG. 11 BREATHER ASSEMBLY FOR FUEL-INJECTION PUMP

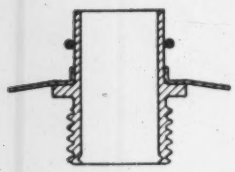

FIG. 12 CONSTRUCTION FEATURES OF BREATHER ASSEMBLY

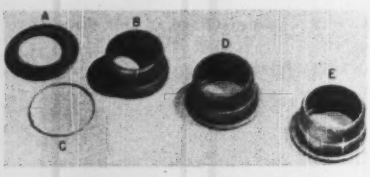

FIG. 13 AUTOMOTIVE CLUTCH SLEEVE ASSEMBLY

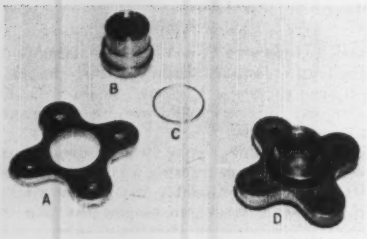

FIG. 14 PULLEY HUB

operation on the flange. While passing through the furnace, the assemblies are in the inverted position from that shown to permit use of round rings instead of hexagonal ones, and to properly direct the flow of the brazing metal by the aid of gravity.

Formerly Machined. The breather assembly for fuel-injection pumps was formerly machined from steel bar stock, but is now made of a small screw-machine part and stamping and furnace-brazed, Fig. 11. The original blank was $1^3/_4$ in. in diam, weighed about one pound, and machined to a part weighing $1^1/_8$ oz. By the present method, the blanks weigh only $^1/_2$ lb, thus saving 50 per cent in material and considerable machining time. As a result, the over-all cost has been cut about 70 per cent.

Two interesting construction features of this assembly are shown in Fig. 12. One is the extruded hole on the stamped flange, to give extra bonding area for good strength, and incidentally, the radius at the corners facilitates assembly. The other point of interest is the shoulder on the screw-machine part, which both indexes the flange and prevents its movement during the furnace-brazing operation in the vertical position shown. Even though such parts have press fits, expansion under heat sometimes loosens them and results in undesirable movement.

The automotive clutch sleeve assembly, illustrated in Fig. 13(E), was originally machined from a piece of bar stock, but is now made from two inexpensive stampings, shown at A and B, with the copper wire ring C preplaced at the joint of the assembly which, at D, is ready for entering the continuous brazing furnace. After the furnace-brazing operation, only one grinding operation is required, and no machining. As a result, material and time have been considerably reduced, plus a substantial saving in cost. About 500 of these assemblies are made per hour in a small mesh-belt copper-brazing furnace with 12-in-wide conveyer.

The pulley hub, Fig. 14, was formerly machined from a section of bar stock about $2^3/_4$ in. in diam, weighing about $1^1/_2$ lb, but is now furnace-brazed using the punching A and screw-machine part B, with copper ring C, the blanks weighing only about $^1/_2$ lb. In this case, about 66 per cent of the material has been saved, and machining time has been materially reduced by substitution of the high-speed press and automatic screw-machine operations. The resulting cost savings are reported to be about $2^1/_2$ cents each. Fig. 15 shows a cross section of the assembly, with a shoulder on the hub indexing and supporting the flange and the copper-wire ring preplaced at the joint.

Formerly Forged. The automotive clutch hub shown in Fig. 16(D) was formerly forged but involved some expensive machining operations on the flange. It is now furnace-brazed,

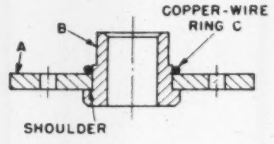

FIG. 15 CROSS SECTION OF PULLEY HUB

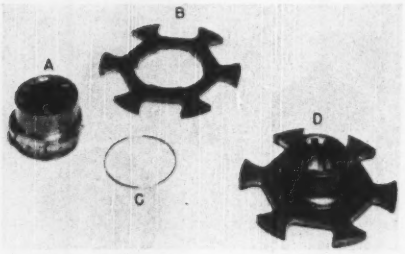

FIG. 16 AUTOMOTIVE CLUTCH HUB

using the splined hub A and punched flange B made from black hot-rolled steel strip, with copper ring C placed at the joint. Savings of 15 cents each are reported from the fabrication of this subassembly. Of interest is the keying action obtained from the notches in the hole of the flange which engage with projections on the hub, resulting in extra torsional strength. The hole in the flange is simply punched, with no reaming or broaching operation employed. Serviceability of the furnace-brazed assembly is reported to be excellent.

An adapter for automobile shock absorbers, Fig. 17(A), was formerly forged, with a large pin welded in at one end. It is now fabricated by furnace-brazing, as shown at B, resulting in reductions of about 30 per cent in weight and 50 per cent in cost, with equal serviceability. Formerly the holes were bored in the bosses in the forging, and the ends faced. Now the cut pieces of steel tubing D have adequate surface finish. The body and washer are punched from black hot-rolled steel

strip C, and the pin E is a small screw-machine part. Half-rings of copper wire F bond the tubes to the body, and complete rings G bond the washer and pin to the body. An interesting construction detail is the knurled portion at the center of the pin. The pin itself has a loose fit in the punched holes of the washer and the body, but the knurled portion gives a heavy interference fit and thus provides an inexpensive way of obtaining metal-to-metal contact, so desirable when copper-brazing low-carbon steel.

The tappet shell, Fig. 18, was a difficult forging to produce because of the rectangular-shaped hollowed-out center. Deviation from specifications for the inside of the forging were common, and minimizing the variation required extra care in manufacture. Subsequent machining was both difficult and costly. First, the forging had to be machined all over, then the odd-shaped hole in the center was machined to size by a laborious end-profiling operation.

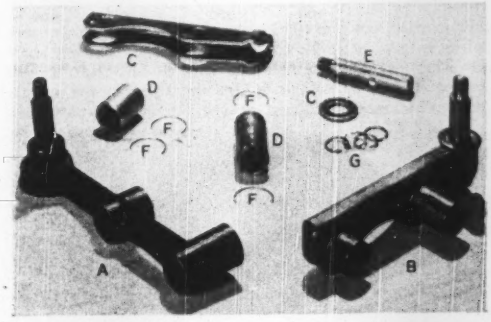

FIG. 17 ADAPTER FOR AUTOMOBILE SHOCK ABSORBER

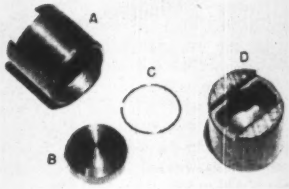

FIG. 18 TAPPET SHELL

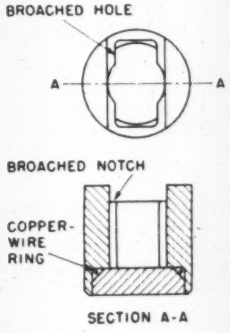

FIG. 19 REDESIGNED CROSS SECTION OF TAPPET SHELL

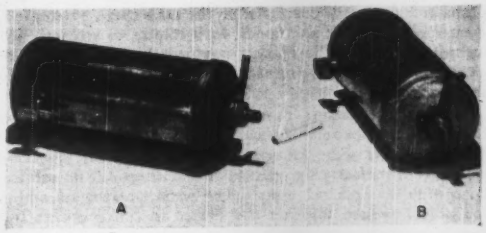

FIG. 20 REFRIGERATOR RECEIVER

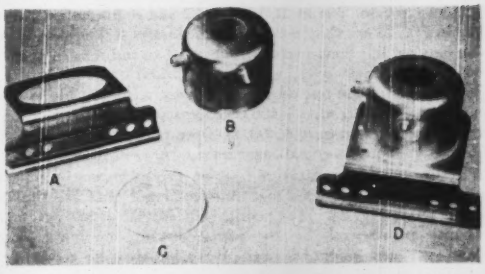

FIG 21 BELLOWS HOUSING ASSEMBLY

The assembly as redesigned for furnace brazing consists of two parts, the body A and disk B, which are made on screw machines. The copper ring C is assembled within the joint, as shown in the sectional view, Fig. 19. Routine manufacturing difficulties have now been completely overcome. The parts are made simply and accurately, and over-all costs have been greatly reduced. The parts are machined with tolerances to give 0.001 to 0.003 in. press fit. It has been found that a light press fit rather than a loose fit gives best strength and uniformity in the furnace-brazing operation.

Formerly Fabricated Some Other Way. There is an assortment of assemblies now furnace-brazed which were formerly fabricated in some other way, such as by torch brazing or welding, pinning or riveting, solder dipping, and the like. The inherent advantages of the furnace-brazing method sometimes afford new benefits.

Refrigerator receivers, Fig. 20, have commonly been torch-brazed or welded, but now are usually furnace-brazed. The assembly at A is prepared with copper-wire rings preplaced at the joints, while that at B has been delivered from the brazing furnace, with all of the joints bonded in a single trip through it. Such multiple-joint brazing speeds production and gives greater reliability of bonds, at lower cost. Of particular importance is the fact that the assemblies come from the furnace immaculately clean and dry. Formerly it was necessary to pickle scale and flux from outside and inside, and then the acid was rinsed out of the inside. There were hazards, in that remaining particles might plug strainers or get into the refrigerator mechanism, and remaining acid might cause corrosion. As a result, the refrigeration industry has gone almost "all-out" for furnace-brazing subassemblies such as these with their clean neat bonds.

The bellows housing assembly, Fig. 21, was formerly torch-brazed, using the steel flange A and brass shell with studs B. It is now furnace-brazed, however, using preplaced rings of silver-brazing alloy and flux, following which the brazed assembly is bright-dipped, as shown at D, to remove flux de-

posits and zinc-oxide coating from the brass shell. Here, too, greater reliability of the bonds with respect to strength and tightness is obtained in brazing trayloads of the assemblies in a controlled-atmosphere furnace, resulting in improved quality at lower cost.

Seven of the leading business-machine manufacturers now furnace-braze subassemblies such as those shown in Figs. 22 and 23. These were formerly pinned or riveted, involving expensive manufacturing operations and short life in service, with high maintenance costs. The furnace-brazed assemblies are simply pressed together and brazed in conveyer-type furnaces, at considerably lower manufacturing costs. They also last the lives of the machines, which greatly reduces the servicing costs. Typical assemblies in Fig. 22 are levers with hubs A, gear-and-cam clusters B, bracket C, and segment with hub D. In Fig. 23 are shown typical cam clusters A, and gear-and-cam clusters B. Such parts are subjected to millions of operations during their lives, with severe vibrations and impact. One accelerated life test on a pinned lever with 800 blows per min showed failure after 1,400,000 operations, while a furnace-brazed lever lasted over 5,400,000 operations without sign of failure, and the test was discontinued.

The results of comparative tests on typical formerly pinned assemblies and the redesigned furnace-brazed ones are shown in the chart Fig. 24. The results indicate 52 to 287 per cent increase in strength by the furnace-brazing method. This means not only longer life of the parts, but they can sometimes be made lighter and smaller, with less inertia and space requirements. In some cases, more functions can be built into a given-size machine or into a smaller machine. The furnace-brazed assemblies show cost savings of 30 to 90 per cent over pinned ones. The work is generally done in box-type or mesh-belt-conveyer type furnaces.

Steel-fin condensers, shown in Fig. 25, were at one time

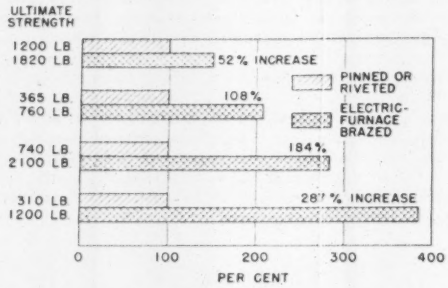

FIG. 24 COMPARATIVE-STRENGTH TESTS ON BUSINESS-MACHINE PARTS

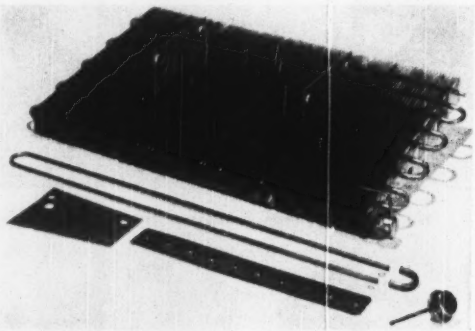

FIG. 25 STEEL-FIN CONDENSER

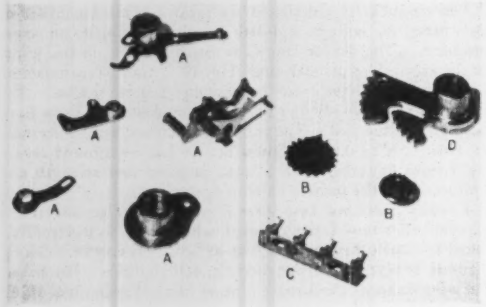

FIG. 22 TYPICAL LEVER WITH HUB-ASSEMBLIES FOR BUSINESS MACHINES

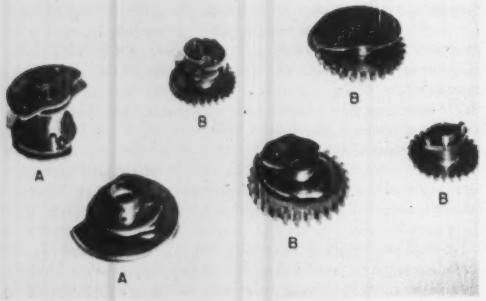

FIG. 23 CAM-AND-GEAR CLUSTERS FOR BUSINESS MACHINES

almost universally solder-dipped. Now, however, they are more commonly furnace-brazed, usually in roller-hearth-type furnaces. In solder-dipping, there was the problem of fluxing and removing flux, plugging tubes to prevent entry of flux, and unplugging them afterward, leaky joints, and low strength of bonds. On the other hand, the furnace-brazed condensers, such as the one illustrated, require no fluxing, are clean and dry outside and inside, are uniformly strong and tight, and are relatively low in cost. The condenser shown is made of a nest of fins and brackets, all with extruded holes, through which hairpins of copper-brazed steel tubing are pressed; the copper coating on the tubing serves as the bonding metal for these joints. U-bends are also assembled on the tubes with copper-wire rings at the joints to assure strength and tightness

A hydraulic coupling unit for automobiles, Fig. 26, was formerly made with vanes which had tabs that projected through the shell and were bent on the outside. It was found, however, that this construction did not have sufficient strength. The assembly was redesigned, therefore, to have a slotted torus ring which rests over the vanes to give them rigid support, and it is copper-brazed in place as illustrated in Fig. 26. The assemblies now have high strength and long life. This is an

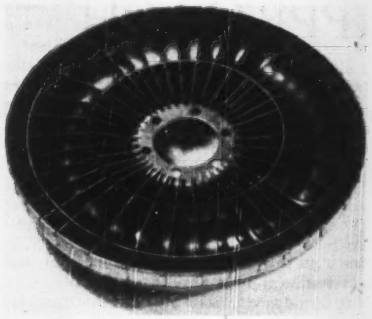

FIG. 26 AUTOMOTIVE HYDRAULIC COUPLING

example of where electric-furnace brazing has been applied, with increased manufacturing cost, to improve quality, reduce service costs, and improve customer satisfaction. Somewhat similar but more complicated assemblies of various designs, also made of steel stampings, are being furnace-brazed for automotive torque converters.

NEW APPLICATIONS

Two relatively new applications of furnace brazing are the bright brazing of high-chromium alloys, such as stainless steels, without flux (2, 3, 4), and the brazing of aluminum alloys with flux (5, 6, 7, 8).

Stainless steels and other high-chromium alloys can be furnace-brazed with flux by the usual procedure in controlled-atmosphere furnaces, but the work comes from the furnace with the characteristic green chromium oxide and flux deposit, both of which usually have to be removed. A technique used in laboratories for some years is now being utilized in production for bright-brazing such assemblies without flux. The method involves the use of pure dry hydrogen or dissociated ammonia atmosphere, which will not oxidize the chromium, and a metal retort within the furnace surrounding the work, to prevent contamination of this pure atmosphere. Although the method is more costly than the conventional process, complicated assemblies, such as that shown in Fig. 27, easily justify the cost.

That assembly is honeycombed with annular grooves and radial holes. In addition, rings with tiny holes are set into shoulders of the grooves, as illustrated at the right. Flux and oxide deposits would be extremely difficult to remove from the inside, and particles would be likely to plug the tiny holes. This assembly, therefore, is a "natural" for the bright-brazing technique.

All-aluminum evaporators (8) for refrigeration, shown in Fig. 28, are now furnace-brazed in order to obtain good contact between the tubes and sheets, thus giving maximum operating efficiency and permitting the use of minimum length of tubing. The aluminum-brazing applications are generally performed in air atmosphere, since flux is necessary and protective atmospheres have shown no advantage with such alloys. Various aluminum-silicon alloys are available as brazing metals, and the furnace temperatures are in the order of 1090 to 1185 F. The assembly shown is brazed in the flat (foreground) in large mesh-belt conveyer-type furnaces and then formed up with shelves inserted (background). Brazing metal for the evaporator shown is rolled on the aluminum-alloy sheet, but brazing foil is extensively used for this type of assembly, also. Aluminum-brazing wire is also available.

Other furnace-brazed aluminum assemblies are torque converters, supercharger intercoolers, outboard-motor tanks, carburetor floats, and the like.

(*To be continued in December*)

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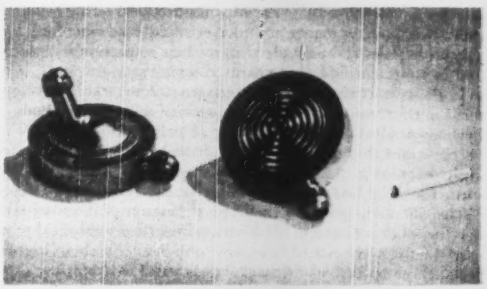

FIG. 27 BRIGHT BRAZING OF COMPLETE STAINLESS-STEEL ASSEMBLY

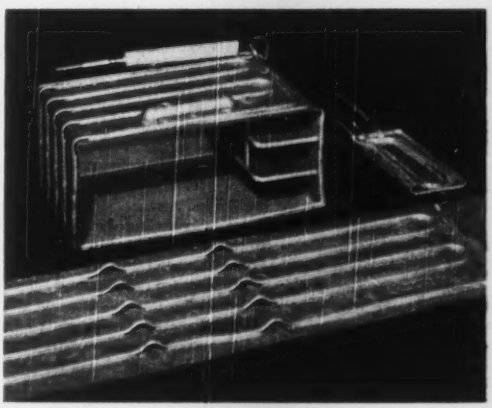

FIG. 28 ALL-ALUMINUM REFRIGERATOR EVAPORATOR

An ENGINEERING APPROACH *to* STABILIZED PROSPERITY

By EDWIN G. NOURSE

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MY remarks this evening will be arranged very simply under three heads: first, a brief prefatory note about economics as a social science; second, a generalized formulation of stabilized prosperity as a problem in economic engineering; and third, a more particularized application of this theoretical approach to the concrete facts of the American economy in 1950.

NATURAL AND SOCIAL SCIENCE DISCOVER AMERICA

Though I am no Methuselah, I have seen a revolution come to these United States. In the late nineteenth century I saw the flowering of natural science and engineering in our universities and institutes of technology. I saw American industry begin cautiously and then advance confidently in the addition of scientists and trained engineers to their staffs. Those among them who were not mere technicians rapidly advanced to top executive posts and to leadership in their respective industries and in our scientific and mechanized economy.

In the twentieth century I have seen a comparable development in the recognition and application of scientific methods of business analysis and the devising of policies and practices in corporations, big and little, in trade and industrial unions, in agricultural organizations, and in government. This development took the line of market analysis, cost analysis, so-called "scientific management," and the perfection of line-and-staff systems of organization. It went on from these analytical processes to the synthesis of company policies. At their highest level, these operative and market policies of the company came to be considered in the perspective of their contribution to—and no less their dependence upon—the functioning of the economy as a whole.

As executives who had been prepared only through engineering training of the older and more traditional sort wrestled with the responsibilities of the top executive posts to which they rose, they came to realize the need of incorporating in their staffs persons especially trained in economics, statistics, accounting, labor relations, and public relations. But they also became convinced that a grounding in such subjects should be included in the basic training of every engineer who aspires to hold an executive post. This is clearly reflected in the manner in which distinguished alumni of our engineering schools have suggested or endorsed the addition of business and economic subjects to the curricula of their alma maters. Some wealthy engineer-executives have founded or contributed to systems of graduate fellowships for executive training, notably those of the Sloan Foundation at the Massachusetts Institute of Technology. Growing appreciation of the importance of economic aspects of engineering problems is reflected also in the attention that the ASME and other engineering societies are giving to the marriage of engineering and economics. It is to this belief that the professional engineer needs to get all the understanding he can from the professional economist that, no doubt, I owe the invitation to meet with you tonight.

This matter, however, has a still wider scope. It concerns the functioning of our representative government in that large area where it touches business and industrial life. This includes not merely the characteristic activities of government in setting up enabling and regulatory acts and administrative agencies to define and police the "ground rules" under which business is carried out. It relates also to the spending, taxing, and monetary functions which reside uniquely within the federal government and that have a dominant aggregate influence on economic life as a whole.

Here too, some revolutionary steps have been taken toward rescuing these activities from the unsuitable domain of politics and in so far as possible infusing them with the spirit and equipping them with the apparatus of science. The Employment Act of 1946 is a remarkable expression of an aspiration to utilize scientific economics in the public service as at least a counterbalance to power politics, if not a substitute for it. While the attempt to do this is at the moment in almost total eclipse, I believe that, once the concept has been registered in a federal law defining appropriate institutions and practices, a new and sustained advance toward its achievement will in due time take place. I strongly hope history will show that new and higher bench marks of performance creditable to a scientific age have been established.

Since I am here asking those of you who are natural scientists and engineers to recognize the claims of those of us who are social scientists and engineers to a co-ordinate role and a team relationship in achieving the full potentialities of industrial America, I should spell out in more concrete detail what it is that I mean.

Economics is an "applied science." It seeks to discover the principles of laws according to which individuals, under our system of private enterprise and representative government, may, through properly organized endeavor, produce as large as possible a flow of goods and services. It seeks also principles for the distribution of this national product through a system of market prices and private incomes and through taxation and public expenditure which will most fully facilitate and stimulate the continuation of the process. I am fond, therefore, of defining the economist as a "wealth engineer."

The economist does not—or should not—merely adumbrate metaphysical concepts and idealistic theories. Nor, on the other hand, should he merely grub around with money-making tricks or with the defence of particular property rights or with trying to justify traditional ways of handling the business affairs of our people. As a wealth engineer, he operates in the fruitful middle ground between these two extremes, bringing scientific analysis—and, in so far as possible, quantitative measurement—to bear upon the study of business forces and market values much as the mechanical, electrical, or chemical engineer brings scientific analysis and measurement to bear upon the forces and materials of nature. Like these other engineers, he

An address delivered at the dinner of the 1950 Semi-Annual Meeting, St. Louis, Mo., June 19–23, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

seeks to find what is wrong with the mechanisms and practices through which we are currently utilizing these forces and materials. And he aspires to contribute something toward their more effective utilization.[1]

Our industrial system may be likened to a giant machine or a power plant which has been designed in the light of the best knowledge available at the time. But this machine is in need of frequent redesigning to take advantage of newer knowledge or to be better adapted to changed conditions. Moreover, if this profit-making machine is to contribute most to the wealth of the nation, it must not only be well designed but also well adjusted. Both design and adjustment require sound knowledge of economic principles. The making of these adjustments rests in the hands of the administrative officers of business concerns, corporate or other, of labor unions, of financial agencies, and of various units of government.

It is frequently remarked in these days that our mastery of natural science has far outstripped our mastery of social science. It would be more correct to say that the technology of inert or passive materials and unchanging natural forces is much simpler than the technology which will organize and direct the not-enslaved actions of infinitely differentiated human beings—aspiring and rebellious, competitive and co-operative, to some extent conditioned but to a great extent whimsical. The demand for individual education and for personal and group self-discipline is something which has no counterpart in the world of natural science.

This is why I emphasize the social or human rather than mechanistic character of economics. Indeed the problem of stabilizing prosperity within our economy must be attacked not merely by the economist but by a social-science team which includes—besides economists and statisticians—political scientists and psychologists, with "assists" from the historian and sociologist.

STABILIZED PROSPERITY AS FUNCTIONAL ADJUSTMENT

With these comments on economics as wealth engineering and on its similarities to and differences from the engineering problems and techniques with which you are familiar, I turn to consider the meaning of stabilized prosperity and the possibilities of attaining it. That is the age-old problem of industrialized or capitalistic society, and there are three general lines of attack upon it which are vigorously espoused by different factions of the public today. At one extreme we have the authoritarian proposal, ranging from mild and beneficent "plan economy" to the harshest kind of autarchy. At the other extreme we have voluntarism, ranging from complete laissez-faire to reliance on the "impersonal forces of the market," operating, however, through institutions of man's devising.

In between these two border areas is the middle ground where most of us live our intellectual lives. We believe in, and are seeking to develop, a free and democratic but scientific system of self-administration through legally constituted groups, private and public. It is definitely on this middle ground that the American people took their stand in the Employment Act of 1946. That is made clear in the Declaration of Policy with which that act opens. It definitely reaffirms the country's devotion to a system of free competitive enterprise and at the same time affirms the "responsibility of the Federal Government to use all practicable means to co-ordinate and use all its plans, functions, and resources...to foster conditions under which there will be afforded useful employment opportunities, for those able, willing, and seeking to work." The clear implication of this statement is that we have the economic "know-how" to produce a great many more goods and services than we have in the past under conditions of frequent business recessions and particularly the prolonged depression of the 1930's.

Even within this middle band between the authoritarian and the automatic organization of economic life, there is difference of opinion as to the machinery by which prosperity or sustained use of the nation's resources could be brought about. One can be called the "aggregate" and the other the "constituent" approach. The first, or aggregate, approach is often called the fiscal-policy prescription for sustained prosperity. The second, or constituent, approach has not been so formally labeled. "Administered prices," "collective bargaining," and "scientific management" are conspicuous as three of its many facets. I myself am prone to refer to it as the "true economic adjustment" approach, contrasted with that of monopoly power or special-interest dominance. I shall undertake to elaborate the meaning of true economic adjustment as we go along, but first I want to contrast it with the approach through fiscal policy or money magic.

Mankind seems to yearn for panaceas or to seek a simple formula for dealing with complex situations. Such an oversimplified philosophy was embodied in the Murray "full employment" bill which preceded the Employment Act of 1946. This measure was predicated on a theory that depressions occur because of lack of general purchasing power. Such shortage of purchasing power, it was held, could be measured in advance by statistical devices now available, and the government could inject into the economy the proper aggregate amount as soon as any symptoms of impending depression were manifest. As a corollary, of course, the government could and should withdraw purchasing power in proper amount whenever it appeared that prosperity was degenerating into boom.

There are several rather serious objections to this way of dealing with the problem of stabilizing prosperity at a high but healthy level. The first is that we simply do not have the statistical techniques by which the necessary diagnosis of future conditions could be made. Second, we do not have a dependable apothecary shop in which the prescription could be correctly compounded, nor do we have an accepted and adequate corps of doctors and nurses by whom it could be administered. The events of 1930 show rather clearly that you can get rapid Congressional action in a time of panic—perhaps too rapid to be soundly considered. But the events of 1947 and 1948 show with equal clarity how impossible it is to get fiscal measures in time of prosperity to damp off an unhealthy boom.

Much more basic than statistical and administrative difficulties is the economic argument against exclusive or primary reliance on fiscal policy as an aggregate remedy. To define an incipient depression as a lack of purchasing power in the aggregate is about as foolish as to say that, because gasoline is the source of power in an automobile, pouring in more gasoline will cure the difficulty whenever the car coughs or sputters or fails to take the hills. The real causes of depression lie in the development of faulty adjustments between the myriad parts of our economy in their price, income, investment, saving, and spending relationships. It is those particular and local adjustments which must be corrected if the engine is to purr sweetly and develop its full potential power.

This does not mean that fiscal policy is not now and for the future one of the major ingredients of national economic policy. Some 42 billion dollars out of a total national income of around 220 billion dollars is channeled through the public treasury, and Treasury operations and policies are closely tied into the operations of our central banking system. The places at which and the manner in which private incomes are drawn upon for public

[1] This paragraph and several that follow are adapted from an address I made in March, 1946, to the Industrial Engineers' Association of Chicago.

purposes, and the places at which and the manner in which public spending feeds these monetary flows back into the spending stream of the market has a very significant effect on demands for goods, on employment opportunities, on propensity or ability to save, and on ability and incentive to invest. But the aggregate influence of these economic processes is derivative and incidental rather than primary and dominant.

Our national propensities, incentives, and capacities to produce and to consume are determined by the bargaining and "administered" processes of the goods and services market, the labor market, the money market, and the capitalized properties market. This market process covers not merely the area of private proprietorships, corporate business, and cooperative associations but also the area of government procurement and federal, state, and local employment. Hence our analysis of how the economic machine is constructed and operated has to deal with the functional relationships of its several working parts and must not be blinded or confused by superficial differences among political or social ideologies. A socialist government in a machine age would still have to struggle with all the basic problems of capital formation and, if it were to be democratic socialism rather than autarchy, would have to wrestle with all the psychological problems of individual motivation and incentive.

While these bargaining and institutionally administered relations of the market are myriad, not to say infinite in their number and complexity, they fall under some five broad categories identifying the several parties at interest. I shall list them as labor, capital, management, agriculture, and government. You will perceive at once that this is not a logically accurate or defensible scheme of classification. Management and capital are not mutually exclusive. The farmer is sometimes primarily a capitalist, sometimes primarily a laborer, but at all times some sort of a combination of both. I use this crude classification, however, because it corresponds to the realities of the alignments into which people as a whole fall in their efforts to run the economy so as to maximize individual incomes and promote national prosperity.

While the two phases of this objective—maximum income for the individual and greatest total prosperity for the economy—are here stated as though they were synonymous or at least internally consistent, we find in practice that the matter is not so simple. In the short run and in the narrow view, the individual, the particular company, or the given interest group may derive temporary or apparent advantage from a course which works against the fundamental and long-run prosperity of the economy as a whole. This is at the root of the perennial struggle between capital and labor, the recently intensified struggle between farm producer and town consumer, and the widespread conflict between businessmen and bureaucrats and/or politicians. The great threat to the achievement of stabilized prosperity comes from the development of localized power or monopolistic strength by any one of the interest groups, and the attempt to exploit this strength to its own immediate advantage. Instead, each such group should try to discover and effectuate functionally correct price and income relationships, that is, the relationship between the productive contribution made and the pecuniary benefit claimed which will in fact promote the sustained and efficient operation of the system as a whole.

If voluntary administration of our industrial process is to proceed on those lines of peace and efficiency that will promote stabilized prosperity, we must master the concept of economic solidarity. From top to bottom—in organized labor, in professionalized management, in government relations, in economic statesmanship, and in the basic understanding and behavior of citizens as voters—our economic life must reflect a broad grasp of the functional relationships among private-interest groups and between private and public forms of organization in the economic sphere.

This was the major premise from which I started my analysis in "Price Making in a Democracy."[2] I quote briefly by way of concluding my generalized formulation of the approach to stabilized prosperity as a problem in economic engineering:

> There is an underlying solidarity of interest among all parts of an economy and hence among all the participants in its business life. Such solidarity expresses itself as a common concern for maximum production. . . . Particular firms in sheltered trades or in peculiar individual circumstances may for all practical purposes seem to lie outside or be able to ignore the principle of economic solidarity. They may pursue their own immediate advantage without regard to the wider repercussions on other companies or individuals or the remoter time effects of any management policy that they may see fit to follow. . . . But . . . as a fundamental principle for businessmen seeking long-run profits for the majority of companies, I see no escape from the proposition that they can make the largest ultimate gains from doing business in a society which is maintained on a high level of activity and low-level costs attained through operative efficiency, and that to the maintenance of such a condition the individual company must consciously undertake to make its own particular contribution, its "cut" in the total product being determined on the basis of its productive contribution, measured with as much scientific accuracy as possible.
>
> I know of no method of statistical or theoretical "proof" that could be invoked to verify so elemental a proposition. It seems to me to state the basic logic of a self-administered business system.[2]

ARE WE PREPARED TO CARRY OUT A STABILIZATION EFFORT?

I have argued that the Employment Act of 1946 soundly reflects a national intention of mastering the recurrent disease of modern capitalism—the business depression—and that the act has outlined machinery and procedures through which an organized, scientific, remedial-and-preventive program may be carried out without loss of our basic liberties. I have undertaken also to outline the character of the responsibilities that devolve upon our several groups as participants in this voluntary process of administering a private-enterprise system within a scheme of representative government. I turn, in closing, to survey the current scene for evidence as to how well we are meeting those responsibilities, how fit we are showing ourselves to be to solve the social engineering problem of stabilized prosperity.

Today, our country stands at a crucial stage in its own history and in the life of the world. With almost fabulous resources in our hands, we are confronted by a fateful responsibility to employ those resources so as to enrich life, preserve liberty, and accelerate the pursuit of happiness not only among our own people but, in reasonable measure, throughout the society of free nations. Many of these countries have been less favorably situated than we are and some of them have made greater sacrifices in pioneering and in preserving human liberties than we have ever been called upon to make.

A voice booms out from the grim towers of authoritarianism to say that free peoples will never discipline themselves and work to a common purpose in developing the strength that is potentially theirs. Thus far we have not decisively refuted that challenge. We have not shown that we can use freedom to pursue our own economic interests as we see them without abusing that freedom so that individuals, companies, or groups overreach their proper place in a well-balanced productive economy and thereby throw it into disorder and impair its productivity.

Agriculture made a promising start toward defining its role as

(*Continued on page 889*)

[2] "Price Making in a Democracy," by Edwin G. Nourse, pp. 423–425.

Electrostatic COLLECTION *of* FLY ASH

By H. J. WHITE,[1] L. M. ROBERTS,[2] AND C. W. HEDBERG[3]

RESEARCH CORPORATION, BOUND BROOK, N. J.

ELECTROSTATIC separators form an integral part of most present-day power-boiler installations. They are not essential for generating steam. They recover a product which in most cases is a nuisance after recovery and expensive to dispose of. The reason for including them lies largely in the field of public relations and community responsibility. That public utilities have long been cognizant of this responsibility is indicated by the fact that the first electrostatic precipitator for power-station fly-ash collection in this country was installed as long ago as 1923, only a few years after the introduction of pulverized-coal boilers in the utility field. Since that time approximately 500 installations have been made in this country.

The magnitude of the fly-ash problem is indicated by recently published figures (1)[4] of the pulverized coal burned by the utilities, which in 1948, amounted to some 65,000,000 tons. On the reasonable basis of an average ash content corresponding to 10 per cent, the quantity of fly ash that could be emitted would be about 5,000,000 to 6,000,000 tons annually. A large modern boiler producing, for example, 900,000 lb of steam per hr will exhaust flue gas at the rate of about 450,000 cfm at 300 to 400 F. With a fly-ash concentration of 2 grains per cu ft, which is a common figure, the dust emission will be 130 lb per min or 92 tons per day. This example, involving treatment of 450,000 cfm of hot flue gas, and collection and disposal of some 90 tons of ash per day, will serve to illustrate the magnitude of the problem involved in preventing atmospheric pollution from this source.

At the present time there are no generally well-defined regulations as to the amount of dust that can be emitted without constituting a nuisance. A considerable number of cities have adopted ordinances to regulate emission, and the ASME has prepared example sections for smoke-regulation ordinances looking toward realistic and economically possible control. In general terms this ASME code gives a maximum figure for dust emission of 0.85 lb per 1000 lb of gas, adjusted to 50 per cent excess air, and a maximum required collector efficiency of 85 per cent. In spite of this, most users of pulverized coal, and this applies particularly to the utilities, have set for themselves the objective of procuring equipment that will provide the highest possible collection of fly ash, both quantitatively and visually.

This situation has led to the focusing of attention on electrostatic separation, which has the ability to remove at high efficiency from a moving gas stream all sizes of particles from submicroscopic to the largest present. It can be carried out in equipment which has long useful life, which imposes relatively low draft loss, and which can be incorporated in space available in most boiler installations. Other practical considerations combine to make it attractive for this operation. Its utility for the service has been proved, but a number of recurring problems have existed which are due primarily to the variable and uncertain nature of fly ash and other conditions of operation. This paper discusses the progress being made in solving these important problems.

FLY-ASH CHARACTERISTICS

Electrostatic precipitation has been employed in many applications other than fly-ash separation, and generally best performance and highest recoveries have been experienced in those cases where both conditions and the material to be collected are reasonably constant and uniform. In many of these installations, efficiencies in excess of 99 per cent in continuous commercial operation are not unusual. In ash separation, the conditions under which a collector must operate vary from installation to installation and in day-to-day operation. Inasmuch as it is not ordinarily practicable to adjust these conditions for best collector operation, the precipitator must provide required performance under whatever conditions prevail.

The fly ash itself is a major variant. It is not a homogeneous or a uniform material. Its physical and chemical properties vary widely, depending upon such factors as type of coal burned, type of furnace, furnace operation, and coal-grinding conditions. The variability of fly ash is illustrated by the table recently compiled by Walker (1) based upon analyses of fly ashes from 46 public utilities and 8 industrials. The earlier work of Davis (2) also shows, by means of detailed chemical and physical analyses, the heterogeneity of fly ash. It is necessary to discuss some of these variable properties and their effect on electrostatic collection.

The most important physical properties of fly ash for electrical precipitation are particle size, particle density, and bulk electrical resistivity. Investigation of the effects of these characteristics are complicated by the difficulties inherent in obtaining representative samples for measurement of properties. Accepted practice (3) calls for sampling and filtering boiler flues on a cross-section basis, using as many as 30 test positions for a large flue. These tests generally extend over a period of 1 hr or more and give reliable samples on which comparisons and calculations may be made with considerable confidence. Hopper or other grab samples are not acceptable except for rough or preliminary examination.

Particle-size observations on fly ash made by means of optical and electron microscopes show particles present from below 0.01 micron diam to over 100 microns. The fraction below 1 micron is usually not important on a mass basis, but a large fraction generally lies below 5 or 10 microns. Some ashes are found with substantial percentages of plus 44-micron (325-mesh) size, but the trend is toward the finer particle sizes for modern public-utility boilers. The results of particle-size analyses made in our laboratory during the past few years on a representative group of fly-ash samples are shown in Table 1.

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[1] Director of Research.
[2] Manager of Development and Research.
[3] Director of Engineering.
[4] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Power Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 19–23, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 REPRESENTATIVE PARTICLE-SIZE ANALYSES

Sample no.	Diameter of particles in microns, Per cent: 0–5	5–10	10–20	20–44	+44
1	25	17	18.5	25.5	14
2	37	19	21	16	7
3	34	32	20	4	10
4	38	28	18	15	1
5	40	24	21	13	2
6	21	21	35	16	7
7	28	24	21	16	11
8	48	18	21	11	2
9	40	19	19	12	10
10	47	21	19	12	1

The specific gravity of fly ash varies not only from sample to sample but also for different particles of the same sample. The average density of a given sample may be measured by means of a pycnometer or equivalent method. Values determined in this way usually lie between 2.0 and 2.7, although these figures do not include the extreme range possible.

Particle shape of fly ash is also heterogeneous and variable. Microscopic examination shows the presence of small, hollow, and frequently transparent or translucent spheres; broken fragments of these spheres; flakes; opaque, irregular particles ranging from pink to brown and black; fused agglomerations of small particles; and irregular, porous, and partially burned large or gritty particles. This is an incomplete description, but serves to indicate the general microscopic appearance of fly ash.

The bulk electrical resistivity of fly ash is important for electrical precipitation. Theory, experiment, and field experience all indicate the existence of a critical maximum value of resistivity of about 2×10^{10} ohm-cm, above which precipitator operation tends to become subnormal due to the onset of intensified sparking caused by the high-resistance ash on the collecting surfaces. This critical value is not sharp, but rather is representative of a diffuse or penumbral region in which precipitator sparking increases and performance tends to fall off as resistivity increases. Quantitative laboratory work on fly-ash resistivity and its effect on electrical precipitation was begun in 1937, followed by similar fieldwork on large precipitators beginning in 1940. The results of this work indicate that the resistivity of fly ash is a function of gas temperature, gas humidity, and, most important of all, the presence or absence of extremely small amounts of SO_3 in the flue gas.

Measurements made on a wide variety of fly ashes under actual field conditions give normal values of resistivity ranging between 10^8 and 10^{10} ohm-cm. A limited number of ashes, however, are found to be in the region of 2×10^{10} ohm-cm, where precipitator trouble is a possibility, and a few in the region of 5×10^{10} ohm-cm, where trouble is virtually certain.

Chemical compounds which, in small quantities, greatly reduce dust resistivity are designated "conditioning agents" and have been used in electrical precipitation for many years. Such compounds are specific for each type of dust, and the proper compound for any new type of dust can be found only by trial. Research work during the past several years has disclosed and proved the effectiveness of SO_3 for fly-ash conditioning. It appears that the traces of SO_3 naturally present in boiler gases are adequate in most cases to maintain the bulk resistivity of the ash below the critical value of 2×10^{10} ohm-cm. The absolute amount involved generally corresponds to the conversion of something less than 1 per cent of the SO_2 content of the boiler gases to SO_3. The troublesome higher-resistivity ashes occasionally encountered are the result of unusually low natural SO_3 content. Artificial addition of SO_3 to operating installations have substantiated laboratory findings on this point. The conditioning effect of SO_3 is illustrated in Fig. 1 wherein ash resistivity is plotted against temperature, with and without SO_3 added. The per cent SO_3 added is relative to the weight of ash used in the tests. The relation of ash resistivity to the precipitation process is brought out in more detail in the next section.

Chemical analyses of fly-ash samples from about 60 public utilities are given by Davis (2) and Walker (1). The major constituents of the ashes are SiO_2, Al_2O_3, Fe_2O_3, and CaO, with the percentage present usually in the order listed. In addition, minor quantities of many other elements are found, including a water-soluble sulphate portion, usually less than 3 per cent, which recent studies have indicated is directly correlated to resistivity.

Other variables which can affect the performance of fly-ash

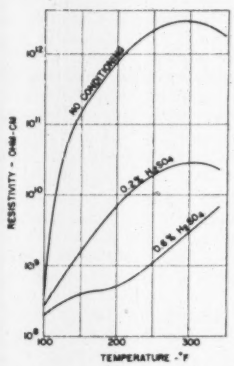

FIG. 1 EFFECT OF GAS TEMPERATURE AND SO_3 CONTENT ON ELECTRICAL RESISTIVITY OF A TYPICAL FLY ASH

precipitators are those which result from, or which are associated with, the increasing size of boilers and the present practice of installing the collector between the air heaters and the induced-draft fans. In the large gas ducts at the air-heater outlets, pronounced stratification is not unusual with respect to temperature, water vapor and CO_2 content (indicating localized air inleakage), concentration and composition of ash, and flow rates or gas velocity. Air heaters and precipitators are normally close-coupled so that any existing stratification carries directly into the precipitators. Many instances of unsatisfactory performance result directly from such stratification, which is largely unpredictable and hence may not always be entirely compensated for in initial design.

PHYSICAL BASIS OF ELECTROSTATIC PRECIPITATION

Many engineering phenomena and processes, such as the flow of electricity in metals or electromagnetic induction, for example, are capable of refined theoretical treatment and control. Electrical precipitation, however, deals with charged particles in gases, whose behavior depends so intimately upon their environment and past history that only approximate calculations are possible at best. General principles are valuable as a guide, but emphasis must be placed heavily upon experience. Nevertheless, a brief discussion of the physical basis and theory of electrical precipitation is desirable as an introduction to the normal functioning of the process, and as an aid in showing the effects of the variable properties of fly ash on precipitator recovery.

The process is based upon the long-known experimental fact that an electrically charged particle experiences a mechanical

force when placed in an electric field. The force is proportional both to the charge on the particle and to the electrical field acting on the particle and is relatively large for easily attainable charges and fields. Electrostatic particle-collection systems clearly must include provisions for electrically charging the particles and for supplying a unidirectional collecting field to capture the charged particles. In the Cottrell or single-stage process, both of these functions are performed in a single chamber by means of the high-voltage direct-current corona discharge maintained between suitable electrodes, e.g., pipes and co-axial wires. The corona discharge supplies vast numbers of gas ions which far outnumber the dust particles. A high degree of particle charge is effected by attachment of gas ions to the suspended particles, while a high collecting field is produced by the electric space charge set up by the large density of gas ions present between the discharge and collecting electrodes.

Charging of the suspended dust particles is accomplished in a few hundredths of a second and hence in the first few inches of the precipitator field. The high degree of charging attained is illustrated, for example, by the fact that a 1-micron particle acquires a charge of the order of 200 electronic charges, while a 10-micron particle acquires about 20,000 electronic charges. Capture of the charged particles, under the conditions existing in the turbulent gas stream in the precipitator, is governed by the laws of probability. Consideration of the physics of the process leads to a theoretical precipitation-rate equation of exponential form, which has been proved to be experimentally correct under controlled laboratory conditions, although usually only partially correct for large field precipitators because of departures from the idealized conditions on which the formula is based.

For uniform particles, the efficiency η may be shown to be (4)

$$\eta = 1 - e^{-\frac{A}{V}w} \qquad [1]$$

where

A = effective area of collecting electrodes
V = gas flow rate through precipitator
w = drift velocity of charged particles in precipitator electric field

The drift velocity w in turn may be expressed by

$$w = \frac{aE^2}{2\pi\theta} \qquad [2]$$

where

a = particle radius
E = effective electric field in precipitator
θ = gas viscosity

A number of important conclusions, as follows, may be drawn from these formulas:

1 Collection efficiency is an exponential function, increasing with A, which represents precipitator size, and decreasing for increased gas flow rate, V.

2 Efficiencies as close to 100 per cent as desired are attainable.

3 Efficiency is independent of particle concentration.

4 Efficiency increases with particle size and is therefore dependent upon particle-size distribution. The expectation that large particles should be collected more effectively than fine particles is found to be true under controlled laboratory conditions. In practice, however, it is found that the scouring action of the gas stream, particularly at higher gas velocities, tends to erode or re-entrain some of the large particles from the precipitator collecting surfaces and, in effect, reduces the collecting efficiency for these particles. The magnitude of the effect varies considerably with conditions, and actual results may show either a higher or a lower relative efficiency for the larger particles. The erosion effect may be reduced or counteracted by reducing precipitator gas velocity and by the use of so-called shielded-pocket collecting electrodes.

5 Efficiency increases directly as E^2, and hence rapidly as the effective field strength is raised. The quantity E^2 may be shown to be approximately proportional to power input, so that power input is a useful index in evaluating precipitator operation. Therefore, one usually strives, with some important exceptions, to make power input as large as possible. It may be noted, however, that the actual power required is always relatively small, being of the order of only 50 to 100 watts per 1000 cfm of gas cleaned. Further, over 99 per cent of the precipitator current is due to the flow of gaseous ions in the corona discharge, while less than 1 per cent is due to the charged ash particles. With ashes of adequate electrical conductivity, precipitator voltages and fields can be maintained at relatively high values, power input is high, and optimum precipitator efficiencies are obtained. High ash resistivity above the critical value of about 2×10^{10} ohm-cm, on the other hand, interferes with the normal corona discharge and causes sparking in the precipitator to occur at abnormally low voltage, with resultant lowered performance. Control of ash resistivity in such cases is therefore desirable in order to insure normal precipitator performance.

The quantity w has the physical dimensions of velocity and may be regarded as a precipitation constant or factor; the larger w the better the precipitator performance and efficiency. Its effective theoretical value for fly-ash precipitators ranges from about 0.7 to 1.0 fps, while actual experimental values determined by Equation [1] directly from field data commonly are 30 per cent to 40 per cent lower.

Until recent years the greatest value of theory has been in establishing guiding principles rather than in the detailed practical development of electrical precipitation, which even today is considered to be largely an art. The theory is necessarily based upon idealized assumptions which frequently do not hold for practical cases. Nevertheless, basic theory and studies of the underlying physical phenomena have been valuable in suggesting new developments, in analyzing performance of precipitators, and in guiding precipitator design.

PRECIPITATOR DESIGN

Precipitator-design problems fall rather naturally into mechanical and electrical categories, and hence are considered separately.

Mechanical. Electrostatic precipitators usually are large compared to other auxiliaries in a power station and an installation frequently requires more space in the steam-generating-unit layout than can be allocated to it conveniently. The resulting tendency to compromise on size sometimes has led to unfavorable operating experience, particularly in those cases where the boiler and the precipitator operate continuously well above design capacity.

Most precipitator installations have been located on the roofs of powerhouses between the air heaters and the induced-draft fans. The recent trend, however, has been toward ground-level locations, either indoors or outdoors. Except for outdoor, ground-level locations, few arrangements lend themselves to later precipitator expansion which sometimes becomes necessary because of increased gas volume or the need for greater collection efficiency.

The basic precipitator-shell dimensions are determined essentially by the maximum permissible gas velocity in the pre-

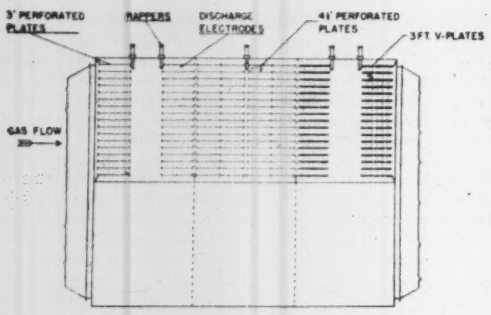

FIG. 2 HORIZONTAL SECTION OF FLY-ASH PRECIPITATOR SHOWING TYPICAL ELECTRODE CONFIGURATIONS AND RAPPER PLACEMENT

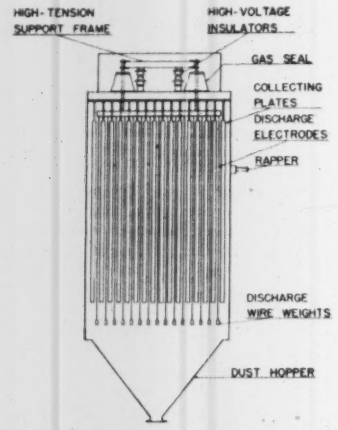

FIG. 3 VERTICAL SECTION OF FLY-ASH PRECIPITATOR SHOWING TYPICAL ELECTRODE SUPPORT MEANS

cipitator and by the total collecting-electrode surface area necessary to obtain the required cleaning efficiency. The useful and practical dimensions for the active precipitation zones in fly-ash precipitators appear to be 15 to 20 ft in height, and 12 to 24 ft in length in the direction of gas flow. Arrangements of the active zones within the shell can be varied so that over-all lengths of 14 to 30 ft, and over-all heights of 22 to 28 ft above the hopper line may be selected. The normal hopper depth is 8 ft. Depending on the height and length selected, the width required for a precipitator of 97 to 98 per cent efficiency will run from 14 to 17 ft per 100,000 cfm handled, while for 95 per cent efficiency it is approximately 20 per cent less.

Long operating experience has proved the necessity for protecting the steel shells of precipitators erected in exposed locations against the corrosive effects of water vapor and sulphur compounds contained in boiler gases. Corrosion is usually confined to limited areas, with the region at the upper part of the shell and the roof being particularly vulnerable. Rain water may enter through small holes which result from shell corrosion and, finding its way into the hoppers, may wet the ash and prevent its removal by the usual means. Gunnite on the interior of the shell and insulation on the outside are effective means for avoiding corrosion. A steel housing over the roof of a precipitator effectively eliminates corrosion in this region. When the precipitator is erected within the powerhouse or other housing, no special provisions against corrosion are necessary.

Fly-ash precipitators generally are of the duct type with horizontal gas flow because of the large gas volumes handled and the large quantities of ash collected. The basic precipitator structure is illustrated in Figs. 2 and 3. In these figures the discharge electrodes are wires and the collecting electrodes are perforated-plate and V-plate type.

Duct width is a compromise between obtaining the largest possible number of collecting plates in a shell and ability to maintain sufficient electrode rigidity and dust build-up space so as not to affect electrical operation unduly. The duct width or free gas passage most commonly used for fly ash is about 8 in.

Electrodes. The corona discharge electrodes usually are round steel wires of about 0.1 in. diam or equivalent twisted square wires and are hung in the ducts at spacings of about 6 in. Burning and breakage of discharge electrodes at the points of support due to precipitator sparking have been experienced in some installations. This condition has been corrected satisfactorily by the use of shrouds at the electrode supports and by insuring low-electrical-resistance contacts at these points.

The discharge-wire support frame is suspended from porcelain insulators mounted in suitable housings on top of the precipitator shell. Tile bushings are used to seal the insulator compartments from the dusty gas stream so that only infrequent insulator cleaning is required. Electrical connections to the high-voltage rectifiers may be made by high-tension cables, or the rectifiers may be mounted on or adjacent to the precipitator itself and direct connections made without the use of cables.

Concrete-plate collecting electrodes were used in the early-type fly-ash precipitators, but their use has been abandoned because of excessive weight and present-day costs relative to fabricated metal electrodes. The metal electrodes have taken various forms, such as perforated or expanded metal plates, V-plates, rod-curtains, and various hollow electrodes with pocket arrangements on the outside surface for conducting the precipitated dust to the hoppers in quiescent gas zones.

Smooth plates usually are not suitable for fly-ash collection, because of the tendency of the gas stream to re-entrain or erode the collected ash from the plate surfaces. The perforated or expanded metal plate, Fig. 4(*a*), provides a multiplicity of close-spaced holes which hold the ash, while the end

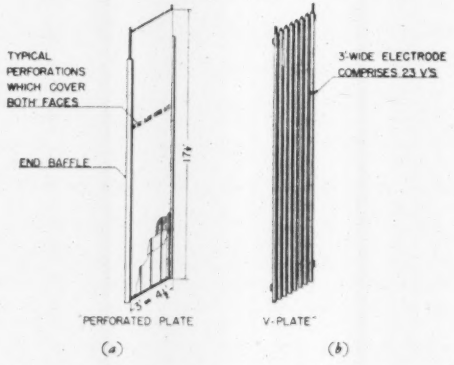

FIG. 4 (*a*) PERFORATED OR EXPANDED METAL ELECTRODE. (*b*) V-PLATE COLLECTING ELECTRODE

baffles on the plate shield the perforated surfaces from the direct scouring action of the gas. The V-plate, Fig. 4(*b*), is a form of shielded pocket electrode and is particularly useful in retaining large and gritty ash particles. The ash collects in the series of vertical slots between the V's, from which it is not easily eroded and yet finds a direct shielded path to the hoppers.

The rod-curtain has some of the defects of the smooth plates. The hollow or pocket type of electrodes are attractive in principle, but in practice it has been found that a large proportion of the dust actually falls on the outside of the plates, while much of that which gets to the inside at the upper openings actually escapes to the outside through the lower openings because of the piston action of the falling dust. Also, they occupy more space in a precipitator than do the perforated or expanded metal type, thereby reducing the active precipitating zone that can be incorporated in a given-size shell. Selection, therefore, largely resolves itself into a compromise between performance, necessity for special provision for grit collection, cost of material and installation under present conditions, facilities required for cleaning, and useful life. On this basis of evaluation, the preference in our judgment appears to lie with the perforated or expanded metal type and the V-type.

Gas Flow. Precipitator gas-flow problems usually start at the outlet of the air heater rather than at the inlet of the collector. It is not practical to adjust the flow pattern after the gases have entered the precipitator, so that means for providing the uniformity in gas distribution essential to optimum performance are normally provided in the flue connection between the air heater and the precipitators.

The basic gas-flow problem is to reduce uniformly the incoming gas velocity from the 25 to 50 fps normally existing in the flue to the 5 to 10 fps required in the precipitator, and to accomplish this with a minimum of turbulence and eddying. This involves expansion of the gas stream and transformation of the excess kinetic energy of the gas, preferably into potential energy or, if necessary, into frictional loss. In most cases it is possible to provide connections with expansion-type vaning which has proved suitable in operation. Many layouts, however, require flues with complicated configurations, and in such situations it is advisable to construct models for study of gas flow before final design, in order to avoid extensive changes after installation.

Most inlet flue designs are based on the assumption of uniform gas flow at the outlet face of the air heaters. This may not exist in operation or may change radically during continued operation of some boilers. Consideration should be given to this factor to the fullest extent possible in the design of air heaters and flue connections, and particularly so if uneven distribution of gas at the outlet of the air heater is likely to result in delivery of unequal quantities of gas to different vertical sections of the precipitator.

Horizontal ledges in the flues on which dust can pile up and change flow lines should be avoided wherever possible, and, where they must be included, consideration should be given to providing hoppers for these sections so that ash deposits can be removed during operation.

Rappers. In precipitator operation, the fly ash builds up gradually on the collecting-plate surfaces and eventually forms compacted layers which to a certain extent tend to fall naturally, but which in most cases require additional removal by a process commonly known as "rapping." This involves a vibrating or jarring action on the plate electrodes sufficient to loosen the ash, which then falls by gravity into the hoppers below. Discharge electrodes in fly-ash precipitators are not ordinarily rapped, as there is little tendency for dust to build up on the wires. An exception is the so-called "combination unit" where cyclonic collectors precede the precipitator.

Far from being a minor adjunct in electrical precipitation, rapping is of the utmost importance in determining over-all performance and has been one of the difficult problems. One may understand this by considering the possibilities which exist for re-entrainment of the ash and for major disturbances and dust-clouding effects in the hoppers due to large masses of falling ash during rapping periods. Many schemes have been devised for easing or avoiding this rapping problem. These include various types of pocket or hollow collecting electrodes, closing of dampers during rapping, and many others. In general, such schemes have only limited application and have been only partially effective in preventing extra loss during the cleaning operation.

With the trend toward higher efficiency and cleaner stacks, the stack-clouding and puffs associated with intermittent rapping of electrodes have become increasingly objectionable, even though it may be demonstrated that the dust loss during rapping will reduce over-all efficiency by only 2 or 3 per cent or less. The psychological effect on the public of such clouding and puffs can scarcely be countered by technical arguments, and the only satisfactory solution is to eliminate them altogether. It is our conclusion, based on the large amount of development work which has been done on this problem, that continuous rapping of closely controlled intensity is the most satisfactory answer to this problem.

In this method the collecting plates are divided into a number of banks, and each bank is vibrated continuously, or else rapped in sequence with a fast-rapping-cycle period of the order of 1 min or less. Visual studies of this rapping method reveal that, when vibration intensities are maintained correctly, the collected ash, which has built up on the plates in appreciably thick layers, becomes dislodged in isolated patches somewhat at random throughout the precipitator. Actually, the ash deposits separate from the electrodes as aggregated masses of limited size, yet heavy enough to fall into the hoppers without being carried along by the gas stream. Obviously, some discrete particles will be washed off the aggregates, but these are reprecipitated. The amount falling at any instant is much too small to produce dust disturbances in the hoppers. This is in contrast to the major dust disturbances in the hoppers which are inherent with intermittent-type rapping. Continuous rapping of closely controlled intensity, in effect, converts precipitation from an intermittent or batch process to a continuous and uniform process. In addition, over-all collection efficiency frequently is increased above that obtained with intermittent rapping because of continuous maintenance of optimum electrical conditions in the precipitation zone.

Most of the rapper systems of the past have been based on mechanical or pneumatic operating principles and suffered from certain inherent limitations and disadvantages such as inflexibility and inability to stand up under field conditions involving moisture, dirt, and corrosive atmospheres. Recently, however, there has been introduced a magnetic-impulse rapper system based upon electric and magnetic principles and free of many of the objections of earlier systems.

The elements of the new system are shown in Fig. 5. The rapping action is delivered by the steel plunger which comprises the armature of an electromagnet. The solenoid coil of the magnet is excited by the impulsive discharge of the condenser, which is timed and controlled by means of the thyratron tube and distributor switch. A number of rapper units, up to 12 or more for a large precipitator, may be energized from one power unit. Both the intensity and frequency of rapping are easily adjustable to meet varied requirements. It may be noted that one of the important practical advantages of this system stems from the fact that the rapper unit has only one moving part, which is hermetically protected against at-

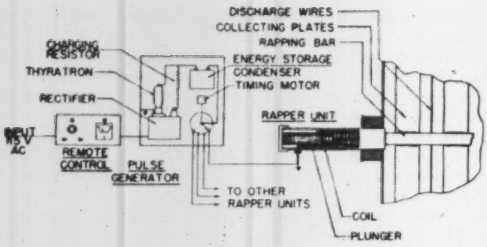

FIG. 5 MAGNETIC-IMPULSE RAPPER SYSTEM

mospheric dirt and corrosion and which is lubricated permanently at the time of manufacture. For continuous operation, the rapping intensity is usually extremely light, corresponding, for example, to the blow delivered by a 1-lb weight dropping about 1 in. under gravity. With this method of rapping, it becomes possible to maintain continuously an essentially clean stack at 98 to 99 per cent efficiency, with no trace of puffs or clouding.

Disposal of Collected Ash. Removal of the deposited ash from the precipitator hoppers is an important function of the gas-cleaning equipment, and must be done with a minimum of ash resuspension. Generally, the removal is done by means of pneumatic or hydraulic equipment, which in the most recent designs is instrumented for automatic operation. The removal is done on either a daily or a shift basis depending on the amount of ash recovered or on the routine practices of each plant. Freshly precipitated fly ash is very fluid and essentially flows like a viscous liquid; however, when cold there is a very definite packing tendency, and it is therefore good practice to handle it in a warm condition.

Difficulties associated with hopper dust removal are (*a*) hopper plugging, (*b*) air inleakage, and (*c*) resuspension of the deposited ash. Hopper plugging can be overcome by adhering to a fixed ash-removal schedule of such frequency that the dust is not allowed to cool and therefore retains its optimum fluidity. Also, the walls of the hoppers must be smooth and free of ledges upon which ash may build up. Hopper vibrators may be used where conditions are such that hopper plugging tends to be frequent. Air inleakage causes resuspension of dust and also tends to increase precipitator sparking. Modern ash-removal equipment seldom gives trouble due to air inleakage but occasionally will account for loss in precipitator efficiency. Dust swirls sometimes occur in hoppers due to defective gas-flow conditions. These tend to reduce precipitator efficiency, but are easily corrected by proper hopper baffling. In general, there appears to be less difficulty with dust removal in the case of continuous collecting-electrode cleaning systems. This can be accounted for by the fact that the dust is continuously falling to the hoppers and there is less chance of any "plunger" action due to the larger amounts of dust which are rapidly dropped during periodic rapping.

Electrical. Although many design and application problems enter into electrical precipitation, the ultimate performance and success in many cases depends more upon establishing and maintaining the proper degree of electrical energization than upon any other factor. Indeed, Dr. Cottrell's greatest contribution to the field was recognition and practical implementation of this fact (6). Much recent research in the electrostatic collection of fly ash has been directed toward improving and stabilizing electrical energization, both in connection with conventional rectifier equipment, and in the development of entirely new methods of supplying electric energy to precipitators.

Both the collecting and discharge electrodes in large precipitators are always subdivided into several groups or sections, and the individual groups are separately energized from individual rectifier sets. This method is used in order to reduce the bad effects of precipitator sparking and equipment outages, and to meet the uneven electrical conditions imposed by the stratification of the gas stream, which frequently occurs and which at present is usually unpredictable. Where gas stratification occurs, it will be found that insufficient sectionalization of the discharge electrodes will reduce precipitator efficiency, and in some cases may be very serious. The degree of sectionalization used in any given case depends primarily on precipitator size and on the cost of rectifier equipment.

High-Voltage Rectifier Sets. Cottrell precipitators are conventionally operated with intermittent unidirectional voltages of negative polarity, obtained from unfiltered high-voltage rectifier sets. This practice stems from Dr. Cottrell's early experiments, which showed rather conclusively that smooth direct-current voltage is unsuited for industrial electrical precipitation and that intermittent voltages generally give superior results.

Until rather recently, synchronous mechanical rectifiers were used almost exclusively in the fly-ash field, and, in spite of some rather obvious disadvantages, have a record of reliable and satisfactory performance. Metallic rectifiers, although used to a considerable extent abroad, have as yet found only limited use in this country because of their relatively high initial cost. Vacuum-tube rectifiers were first tried in electrical precipitation about 30 years ago, soon after their commercial development, but were found to be unsatisfactory due to short and uncertain life. However, continued development by tube manufacturers as well as the general advance of the science of electronics has corrected most of the former uncertainties in tube manufacture, and present-day tubes in electrical precipitation service show average lives of at least 20,000 hr (2 years, 3 months) with figures of 30,000 hr not uncommon. Tube rectifiers have many recognized advantages, and permit the building of quiet, compact, and efficient rectifier sets which do not generate noxious gases and which require little or no servicing for long periods. These advantages, combined with established long-tube-life records, are leading to the acceptance and wider use of tube rectifiers in the fly-ash collection field.

Large fly-ash precipitators generally require at least three rectifier sets and may use as many as six. Rectifier connections, Fig. 6, are either half-wave or full-wave, but the half-wave connection is preferred, as it permits a greater degree of precipitator sectionalization with a given number of electrical sets. Full-wave is sometimes used on outlet sections, however, in order to supply the greater corona current demand required for these sections.

Field research during the past several years has established the fact that, contrary to earlier ideas, optimum collection efficiency for fly-ash precipitators usually occurs with precipitator voltages set not at the sparking value but substantially above it. The optimum degree of sparking has been found to depend upon many factors, and in order of magnitude is most commonly about 100 sparks per min per precipitator section. Readjustment of fly-ash precipitator voltages to conform with these new results has led to pronounced improvement in precipitator performance.

Automatic Voltage Control. A further result of this research has been the development of an automatic voltage-control system which continuously maintains precipitator voltages at the optimum values for maximum dust recovery. This is particularly important in fly-ash precipitators which, as has been noted, are frequently characterized by rather wide day-to-

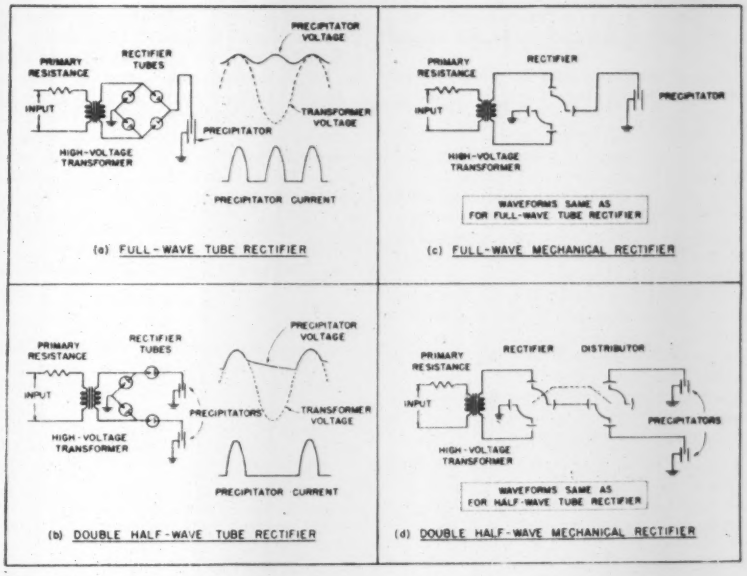

FIG. 6 ELECTRIC WIRING DIAGRAMS, WITH VOLTAGE AND CURRENT WAVE FORMS FOR PRECIPITATOR RECTIFIER SETS

day or even hour-to-hour variations in electrical conditions. The control system is based upon the periodic or continuous determination of precipitator sparking rate, comparison of this measured rate with a predetermined optimum value, and use of the differential or error signal thus generated to raise or lower the precipitator voltage to provide the required compensation in sparking rate. In practice these functions are performed by a rather small apparatus which weighs only a few pounds and which is, in effect, an adjunct to the primary voltage control circuit.

Pulse Energization. A basically new system of supplying high-voltage power to precipitators, known as pulse energization, has been under development since 1947. This system essentially comprises a high-voltage high-power pulse generator capable of supplying high-voltage pulses of the order of 100 microseconds duration at a frequency of several hundred pulses per second, which in turn may be commutated to as many as four or even six precipitator sections. The method provides the following basic advantages, as compared with the conventional rectifier-energization method:

1 Greater degree of precipitator sectionalization.

2 Higher peak voltages and increased corona power through adjustment of voltage, frequency, and wave shape to fit individual precipitators.

3 Inherent current and power-limiting action during precipitator sparkover because of the stored-energy-type pulse circuit used.

CONCLUSION

The present trend in pulverized-coal-fired boiler combustion-gas cleaning is toward virtually perfect stacks at all times, or, if not perfect, to provide the actual practical maximum removal which can be maintained. This progressive attitude is due not so much to the increasing stringency of municipal regulatory laws or ordinances, but rather to a sincere desire on the part of engineers to eliminate any possible nuisance and to maintain good public relations. The trend toward cleaner stacks has been consistent since the time of the earliest fly-ash-precipitator installations and is manifested in the many requests for equipment providing 97 per cent to 98 per cent efficiency.

Although electrical precipitation has proved a most useful method for preventing the emission of fly ash, actually to the extent of providing in some cases visually clear stacks and quantitative efficiencies in excess of 98 per cent, there are complex problems inherent in its application and operation which require better solutions than now exist before complete and permanent elimination of atmospheric pollution from all pulverized-coal-fired boilers is to be attained.

Practical solutions now exist for most of the problems pertaining to design and arrangement of equipment and to maintaining it in operative condition. It is not uncommon for all sections of a precipitator to be continuously available for service from one boiler outage to the next. On the other hand, there are the more difficult functional problems which have to do with variations in ash characteristics, particularly its resistivity, and with stratification at the precipitator inlet. Methods for providing greater uniformity ordinarily are limited to the collector itself and to the connecting gas flue from the air heater, since the nature of the application is such that the ash collector must function under whatever boiler operating conditions happen to exist. There are, however, several promising methods now in progress or recently applied for combating these nonuniform and variable conditions. These may be summarized as follows:

1 Continuous rapping of electrodes at controlled intensity to eliminate stack puffs and clouds and to maintain optimum electrical conditions in the precipitator.

2 Automatic voltage control which holds voltages at the

optimum values for maximum recovery rather than for the most difficult conditions that may prevail over the usual 8 or 24-hr hand-control period.

3 The pulse method of energizing with its promise of economically subdividing precipitators into a greater number of individually energized sections.

4 Combination collectors comprising centrifugal separators preceding precipitators. Centrifugal separators have high resistance to gas flow relative to electrical precipitators, and in a combination they are useful in establishing uniform gas flow, particularly in those cases where it cannot be readily provided in the flues to the precipitator. Also, they level out the stratification in ash content and ash composition that frequently exists at the inlets of precipitators.

5 Conditioning of the ash to maintain its resistivity below the critical value of 2×10^{10} ohm-cm. By increasing artificially the trace amounts of SO_3 naturally present in boiler combustion gases, it is possible to reduce the resistivity of the ash to a point where high precipitation rates are possible. This method holds promise of providing the means for handling abnormally high-resistivity ashes at top efficiencies and at flow rates which result in units of economical size.

It is clear that advances in the electrostatic collection of fly ash have resulted largely from basic studies of the process and from better and more quantitative understanding of the nature and significant properties of fly ash under actual field conditions. Fundamental analysis has pointed the way to elimination or alleviation of important difficulties and has uncovered promising fields for future advances. One of the important limiting factors, however, has been field testing, which is difficult and expensive, but which is essential for basic work and for evaluation of precipitator performance. The wide variety of fly ashes and of plant operating conditions constitute a serious burden in carrying out a program of this type.

Further development of electrical precipitation in the fly ash field may be expected along the lines of more uniform performance and maintenance of the continuously high efficiencies which will undoubtedly be desired for the majority of installations. These improvements can be accomplished by continuing co-operation of engineers, both in obtaining necessary basic information and in accurate and objective appraisal of problems.

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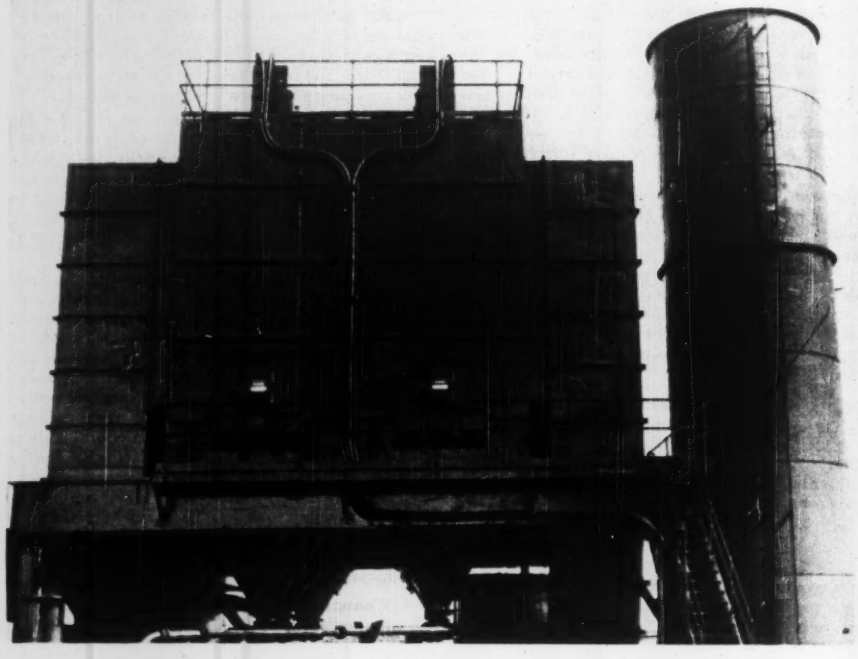

FIG. 7 EXTERNAL STRUCTURE AND ARRANGEMENT OF TYPICAL FLY-ASH PRECIPITATOR

The HUEY GAS TURBINE

Engineering and Construction Problems Involved in Installation

By C. C. WILLIS[1] AND E. C. GOLDSWORTH[2]

THE purpose of this paper is to describe the engineering and construction problems involved in the application of a 3500-kw simple-cycle locomotive-type gas-turbine-generator unit to an existing electric-utility steam plant.

REASON FOR SELECTION

Huey Station of the Oklahoma Gas and Electric Company was originally put into operation in 1930 with one 30-mw turbogenerator unit and three boilers designed for 150,000 lb of steam per hr output each at 400 psi 750 F, on the basis of burning coal fuel eventually. However, since gas fuel was readily available from the Oklahoma City area, coal-burning equipment was omitted but oil-burning facilities were installed as stand-by to gas.

During the war a second 20,000-kw turbogenerator unit of conventional design was installed in the building in the space previously occupied by a machine shop on the main turbine-room floor. The total boiler capacity equivalent to 51,000 kw was utilized completely by the addition of the second unit, but the turbines had a combined capability of 56,000 kw. Since the postwar system demand increased more rapidly than expected, it was essential that additional economical capacity be installed as quickly as possible. Therefore the Huey Station with some 5000 kw more turbine capacity than was available from existing boilers offered possibilities for increased capacity.

Several proposals were considered for making up the deficiency in steam-generating capacity and for making available the additional 5000 kw from the turbines as follows:

1 The installation of a fourth boiler; but the increasingly high cost of large boilers and slow delivery made this proposition unattractive for the immediate situation.

2 Supplying steam from external sources for heating feedwater.

3 Separately gas-fired feedwater heater.

4 The installation of a simple-cycle gas turbine operating on natural gas and equipped with exhaust-gas-recovery heat exchanger for feedwater heating.

All of these propositions, except the gas-turbine installation, would result in increasing the capability desired, but at a sacrifice of station heat rate. Therefore, in February, 1948, it was decided to purchase a nominally rated 3500-kw locomotive-type gas-turbine unit, equipped with an air precooler and a gas heat exchanger for heating the steam-plant feedwater. Studies showed this combination would result in a 7000-kw gain in plant capability—4000 from the gas-turbine-driven generator unit and 3000 from the release of extracted steam for generation instead of feedwater heating.[3] The original installation of the Huey Station was designed by the Byllesby Engineering and Management Corporation, now the Pioneer Service and Engineering Company of Chicago, so the task of designing this gas-turbine extension was assigned to that company.

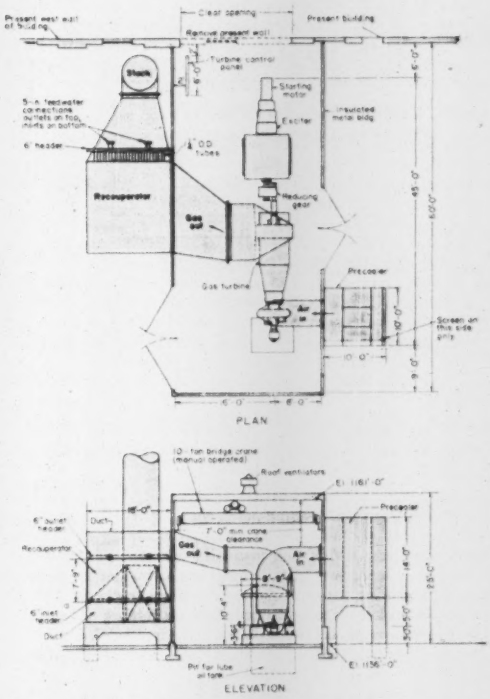

FIG. 1 GENERAL ARRANGEMENT, PLAN AND ELEVATION

GENERAL ARRANGEMENTS AND CONNECTIONS TO EXISTING STATION

The general arrangement of the gas-turbine installation is shown in Fig. 1, with the main building 60 ft long × 24 ft wide × 25 ft high covering the gas-turbine-generator unit proper. The air precooler, recuperator for feed heating, and stack are located outside of the building. The gas-turbine building and equipment were located as an extension to the west end of the main plant building in a location for a possible future addition of two more gas-turbine units of the same general size and design, since the one installation would heat approximately only one third of the feedwater required for full load on the main steam boilers. Also, the extension is located in such a manner that if desired in the future the fourth main steam boiler may be added as an extension to the existing boiler room.

The operating level for the gas turbine is the same as that in

[1] Superintendent of Generation, Oklahoma Gas & Electric Company, Oklahoma City, Okla. Member ASME.

[2] Engineering Division, General Electric Company, New York, N. Y. Member ASME.

[3] "Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant," by Alan Howard, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 301–306.

Contributed by the Gas Turbine Power Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 19–23, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

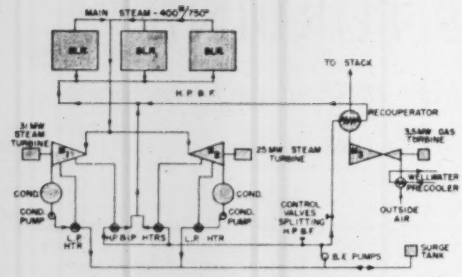

FIG. 2 SCHEMATIC DIAGRAM OF BOILER-FEED SYSTEM, SHOWING INTERCONNECTION WITH GAS-TURBINE RECUPERATOR

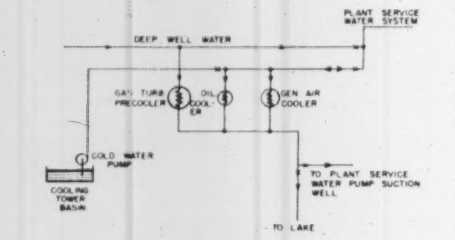

FIG. 3 SCHEMATIC DIAGRAM OF SERVICE-WATER AND WELL-WATER PIPING TO GAS-TURBINE OIL COOLER, GENERATOR AIR COOLER, AND AIR PRECOOLER

the main-plant turbine-room basement floor which is at ground level, so that the unit can be attended easily by the existing operating forces. A 10-ton manually operated overhead crane with power hoist was installed in the gas-turbine-house structure for servicing the unit, and for loading the gas turbine on a truck to be taken to location under the main hook of the steam-plant turbine-room crane for dismantling in a vertical position. The building was built of structural steel with insulated metal siding and steel casement windows.

The foundation for the gas-turbine generator unit contained approximately 126 cu yd of reinforced concrete and, since the installation was made at ground level, considerable excavation was required to put the turbine lubricating-oil tank into position below the governor end of the turbine. Also, the generator leads, water piping for cooling the generator, and fuel piping were brought in under the floor.

The connections to the existing station for feedwater, electrical facilities, and service water were made in the conventional manner. Fig. 2 is a schematic diagram showing an extension from the main boiler feed discharge header through the exhaust-gas recuperator and back into the main feedwater system to the three gas-fired steam boilers.

A 4000-kw, 0.8-pf, 13.8-kv, 3600-rpm generator, which was slightly oversize for the nominal rated 3500-kw turbine, was selected. Subsequent operation at 5000 kw during cold weather shows that this choice was justified. The output for the generator is taken by cable through an underground duct run to the OCB in the main substation for distribution or step up to 66 kv to the transmission system. The electrical requirement for the auxiliary equipment, such as the 250-hp starting motor, oil pumps, and cooling-water pump, was taken from the existing station power supply at 2300 and 440 volts.

The turbine is started from the cabinetrol adjacent to the unit. When the unit is up to speed, control is turned over to the switchboard operator in the existing control room for synchronizing and loading.

The service and well-water facilities to the gas-turbine extension are shown in Fig. 3. This arrangement provides for using the existing steam-plant service-water supply to the oil cooler and generator air cooler. The generator air cooler was purchased for 95 F water. Since the main-plant service water is taken from the lake which is used for condenser cooling and may go to 105 F in the summertime, a vertical service-water pump was installed in the base of an existing cooling tower to provide 90 F water to the generator air cooler and oil cooler under adverse conditions as to loading and service-water temperatures. This piping arrangement also provides for supplying 63 F water from deep wells to the air precooler in the gas-turbine air-compressor inlet during high-temperature days in the summertime. This latter provision results in an increase of some 630 kw in capability with an average increase of 225 kw.[4]

SELECTION OF ACCESSORY EQUIPMENT

Recuperator or Heat Exchanger. Considerable study was given to the most practical and economical arrangement for the recuperator to reclaim the heat from the gas-turbine exhaust to heat the feedwater for the steam boilers. Consideration was given to a heat exchanger which could be gas-fired for heating the feedwater when the gas turbine was out of service, or to augment the waste heat from the gas turbine. Also, designs were considered for passing the full station feedwater requirements of some 600,000 lb per hr. The recuperator purchased was designed around the following specifications:

Water flow, lb per hr	350,000
Gas flow, lb per hr	344,000
Gas temperature entering, deg F	780
Gas temperature leaving, deg F	324
Water temperature entering, deg F	185
Water temperature leaving, deg F	295

Air Precooler. Since the gas-turbine compressor handles air at constant volume, there is obviously a reduction in capacity during high ambient temperatures in the summer owing to less pounds of air being handled by the compressor. There are two deep wells in the plant yard for supplying make-up to the circulating-water cooling lake, and for critical cooling of certain auxiliaries in the summer. It was determined by calculation that by using three sections of discarded finned-tube generator air coolers supplied with well water, that a gain of 750 kw in gas-turbine capability (26 per cent) could be effected when ambient temperatures were at 100 F. Three cooler sections having an effective surface of 30,000 sq ft were rebuilt and installed vertically with the inlet and outlet heads at the bottom at the gas-turbine compressor inlet just outside of the building. These cooler sections were designed to handle more air in their original location on the generator than would be required for the gas-turbine installation, hence the drop through the air side with 328,000 lb of air per hr to the compressor inlet was calculated to be less than 1 in. of water. The air coolers would be supplied with from 400 to 700 gpm of 60–65 F deep-well water as required, with very little temperature rise, hence return from these coolers was piped in such a manner that the cool water can still be used in the existing plant service-water system for critical cooling. It was necessary to series the water through these cooler sections to eliminate air binding.

Emergency Service Water Pump. Cooling-water requirements

[4] "Huey Gas Turbine Ticks off 3400 Hours," by J. W. Blake and R. W. Tumy, *Power*, vol. 94, 1950, pp. 96–101.

for the gas turbine proper were specified as follows when supplied with water at 95 F:

Generator air cooler	120 gpm
Turbine oil cooler	200 gpm

The service-water piping arrangement to supply these facilities as well as the air precooler are shown in Fig. 3. Since the regular plant service water which comes from the main circulating-water cooling lake may reach 105 F in the summer, a vertical submerged pump having 400 gpm capacity with 75-ft discharge head was installed in the basin of an existing auxiliary-cooling tower for emergency use during extremely hot weather. This pump was used approximately 2 months during the 1949 summer season.

Gas Fuel Compressor. The gas-turbine manufacturer requires natural gas to be available at 150 psi to the gas turbine in order to insure full output under most adverse conditions. While the Huey Steam Station is located on the main transmission system of the gas company, and the gas pressure seldom drops below 150 psi, except during extreme cold weather or difficulties on the transmission system, it was decided that in order to insure operation of the gas-turbine unit when the main gas pressure might drop below 150 psi and to take care of any future changes contemplated by the gas company, a gas booster compressor should be installed in the fuel supply line to the gas-turbine unit. For this purpose a motor-driven rotary gas compressor, operating at 690 rpm, was supplied. This compressor is capable of boosting 100,000 cu ft of gas per hr from 100 psig suction to 170 psig discharge. The compressor is equipped with a 75-hp motor and is designed for outside service with no protective covering or water cooling. It was located on a slab adjacent to the main gas-regulator station for the plant some 600 ft away from the gas turbine. Controls were provided for starting it automatically at some predetermined suction pressure and likewise shutting it down when the main-line pressure has reached 170 psi. In addition, for maintenance and emergency requirements, a manual-control station was extended to the cabinetrol in the gas-turbine building for starting and stopping and a switch for going from automatic to manual control. An automatic relief or by-pass valve is installed in the compressor discharge with the outlet piped to the low-pressure gas-fuel supply line to the main steam-fired boilers. Provisions were made for installation of a cooler in this by-pass line in the future if required.

In addition to these facilities, an emergency shutoff valve has been installed in the gas line to the gas turbine in the plant yard. This emergency shutoff valve may be tripped from the gas-turbine control panel and at another location in the main steam-plant building away from the gas-turbine house.

Feedwater Control. Since the recuperator or heat exchanger was sized to take only part of the main steam-station feed requirements, and owing to the desire of arranging the piping so that the feedwater normally could be routed through the recuperator in parallel with the extraction heaters, with a possibility of going to series operation or 100 per cent flow through the recuperator during light loads, a special flow-control arrangement was indicated. Fig. 2 shows the essential feedwater auxiliaries and piping with the interconnections to the recuperator in the gas-turbine exhaust. The main steam boilers are equipped only with radiant superheaters, and this results in the corresponding reduction in steam temperature as the feedwater temperature is increased. Therefore, in order to obtain the maximum benefits from the over-all economy standpoint, it was necessary to set up the feedwater-control scheme on a two-stage basis for operating the diaphragm valves from a temperature element in the feedwater line to the boilers, combining the outlet from the recuperator and the extraction heaters. The second stage or bias to the feedwater temperature was originated from steam temperature in the manifold supplying the two main turbines. This control arrangement was to be made adjustable to hold constant steam temperature between 690 to 760 F and feedwater temperature in the range of 240 to 320 F.

The head-capacity characteristics of the existing boiler feed pumps were established by the original installation. This made it necessary to study the feedwater pressure drops through the recuperator, and the control valves installed in the feedwater line, to be sure that adequate feed-pump capacity would be available with the addition of the new equipment. The control cabinet for the boiler-feed and steam-temperature devices installed with the gas-turbine recuperator was located in the main-plant turbine-room basement near the boiler feed pumps.

Air and Gas Ducts. Arrangement of the air and gas ducts to and from the gas turbine are shown in the general layout, Fig. 1. The air-intake duct between the air precooler and the compressor inlet is equipped with a silencer, guide vanes, and a fabric expansion joint in the vertical run above the compressor. This arrangement is effective in suppressing noise in the area surrounding the building.

The maximum allowable thrust on the turbine exhaust is limited to 1000 lb. Owing to the complicated shape of the exhaust duct, its rigid connection to the recuperator or heat exchanger and necessity for supporting the duct under the crane, numerous problems were encountered in working out a satisfactory flexible connection between the exhaust duct and the gas-turbine outlet. The original bellows-type expansion-joint arrangement did not work out, since single joints of this type cannot take shear. It appears that the best solution is the use of a fabric which can stand temperatures of 800 to 850 F, and this is in the process of fabrication for the unit.

Heat insulation was installed on both the air-inlet duct and the gas-outlet duct as well as around the recuperator which was located outside the building.

The gases leaving the recuperator are conducted above the top of the main building by an unlined steel stack.

GAS TURBINE—CHANGES TO ADAPT UNIT FOR STATIONARY ELECTRIC-UTILITY OPERATION

The gas turbine was originally designed for railroad locomotive application.[3] In adapting it to stationary utility operation, some changes and additions were required.[5]

In railroad service the turbine drives four direct-current traction generators through a reduction gear. In the Huey application the gas turbine drives the alternating-current generator through a single-reduction double-helix reduction gear. Although this installation is rated at 3500 kw, the reduction gear and generator were designed for 4000 kw in anticipation of an up rating of the gas turbine with reduced ambient temperatures. The generator is coupled directly to the main gear, and the thrust bearing for the reduction gear and generator are mounted on the main gear shaft.

In railroad service the unit was rotated to firing speed by using one of the traction generators as a motor. Power was supplied to this generator from an auxiliary Diesel generator. For this installation a 250-hp wound-rotor induction motor was installed for rolling the unit at $^1/_8$ speed for purging and up to approximately $^1/_2$ speed for the firing cycle. This motor drives through a speed-increasing gear and is connected to the main shaft by means of a jaw clutch. The starting motor is used only during the starting cycle; during operation it remains idle.

[5] "3500-Kw Gas Turbine Raises Station Capacity by 6000 Kw," by J. W. Blake and R. W. Tumy, *Power*, vol. 92, 1948, pp. 518–525.

The starting motor does not develop sufficient breakaway torque to start the main shaft turning; so it was necessary to build a turning gear into the main reduction gear. The turning gear also allows slow rotation of the unit for maintenance inspection and for cooling at shutdown.

The lubrication system is of the simple pressure-feed type. A main oil tank of 1200 gal capacity, containing the oil pump and coolers, is used. The turbine oil pump supplies all the pressure-fed bearings throughout the installation. Bearings used are of the pressure-fed babbitt sleeve type. For starting and shutdown, the unit is provided with a motor-driven lube-oil pump. For emergency shutdown a direct-current-driven lube-oil pump is provided which will supply lubrication while the unit is coasting to a stop.

In order to make the unit completely automatic in starting and operation, a number of protective devices were added to the basic unit. These devices are of two types. The first type will cause immediate shutdown of the unit, the second type will give a warning and then a shutdown of the unit after a small time lag.

Alarm and immediate shutdown are caused by the following:

1 Fuel failure.
2 Low lube-oil pressure.
3 Flame failure.

A preliminary warning alarm and then shutdown if the fault is not cleared are caused by the following:

1 High exhaust temperature.
2 High bearing temperature.
3 Excessive vibration.

This installation is completely insurable and, at present, is covered by normal insurance coverage. At the present time the insurance underwriters have not established a definite rate for this type of installation but are in the process of setting up standards to cover such installations.

CONSTRUCTION AND ASSEMBLY

The installation of this gas-turbine generator in many respects is a duplication of the procedure used in making a steam-turbine-generator installation. The generator, gear, exciter, and oil tank used are of standard steam-turbine design. The units were all installed using the standard-installation methods.

The gas turbine was shipped completely assembled, ready to be set on its foundation. This eliminated any turbine-assembly time and also allowed shipment of the gas turbine exactly as it was assembled and operated during factory testing.

The foundation required for the gas turbine is relatively simple. A total of twelve foundation bolts is all that is used for the gas-turbine section of the installation.

The installation of the gas turbine is further simplified by the elimination of any high-pressure high-temperature piping, and a cumbersome condenser and its connections. A unit of this type eliminates also the necessity for a steam-boiler installation.

Due to its unique design, the turbine is held rigidly in line at only two points. The main and fixed support is located aft of the turbine casing and is called a ball support. This support is a ball joint, and anchors the aft end of the unit in position and forces all expansion forward. To prevent side and twisting motion, the gas turbine is supported at its center section by two hinged trunnion supports. In order to keep the unit in line, a key and set of gibs are provided on the bottom center line of the unit.

The trunnion supports are provided with spherical bearings at both ends so that the gas turbine can expand freely. With the unit anchored at its extreme aft end, all of the expansion takes place toward the inlet end. This expansion is on the order of $\frac{1}{4}$ in. at full load.

Since the unit had only one solidly fixed point to hold it in place, a set of alignment fixtures was designed in the factory and furnished as special installation tools. These fixtures consisted of two sets of parts; one set was used at the aft end and one set at the forward end. The fixtures were designed to allow complete controlled movement of the gas turbine in all directions during alignment. The aft-end fixture was so designed that a large shim could be fitted and installed between the ball support and its base plate. This feature was very valuable since it allowed easy and perfect fitting of the shim without losing the turbine alignment. After the turbine was aligned so that its coupling was in exact alignment with the pinion-gear coupling, the trunnion support and mid-guide soleplate were shimmed to elevation and bolted down.

When the aft-end support and the trunnion supports were set, the alignment fixtures were removed. This then left the gas turbine mounted on the aft-end support and the trunnion supports. No support was under the inlet casing of the unit. This is the actual operating condition of the turbine. All of the compressor section is cantilevered from the trunnion supports. The unit is designed so that it is rigid enough to support its own weight and hold itself in alignment as a unit. A spring-loaded vibration damper is installed under the inlet casing to prevent violent vibration of the unit in case of some difficulty which might cause high vibration.

The gas turbine is connected to the reduction gear by means of a 15-in-long spline shaft. This eliminates any possibility of the turbine applying axial loading on the reduction-gear thrust bearings.

Since this unit has complete automatic starting and operation, considerable control equipment is required as well as a number of automatic temperature recorders. The control cubicles were shipped fully assembled from the factory and were set on the foundation provided. All that was necessary to connect the control equipment was to make the interconnections between junction boxes provided on the turbine and corresponding points at the control cubicles.

No difficulty was experienced with the lube-oil system in the field since it was all routine pipe work. Most of the piping was assembled in the field, and to avoid scale and dirt damage to the bearings a very thorough job of "pickling" and flushing was done on this piping. The time spent on this work was well justified since there was no evidence of dirt in any bearing on the unit.

This unit was never run on natural gas before it was shipped from the factory and there was some apprehension as to how it would operate. This worry was in vain—since the unit fired off on the first attempted start and operated very well. The combustion was very clean and to date there has been no difficulty with the combustion system.

The actual construction and installation of the building and accessory equipment for the gas-turbine unit was rather uneventful. The excavation for the gas-turbine building was started January 15, 1949, and was delayed some due to wet weather in the spring, but by April 15 the turbine foundation was completed. The gas turbine arrived at this time but was not set in the foundation until the building was completed early in June. Erection of the recuperator and precooler was finished by July 15; and on July 29, at 2:15 pm, the unit was synchronized with the main system and ran for 3 hr without any unusual developments. Maximum vibration has been in the order of $\frac{1}{2}$ mil. Total time for construction from breaking ground to going into service was $6\frac{1}{2}$ months. The time spent

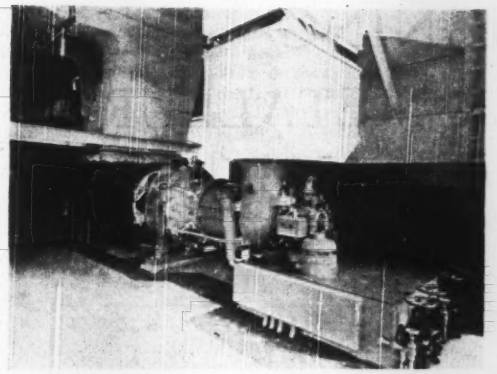

FIG. 4 GAS-TURBINE BUILDING, SHOWING GAS-TURBINE UNIT, GENERATOR, AND AUXILIARIES

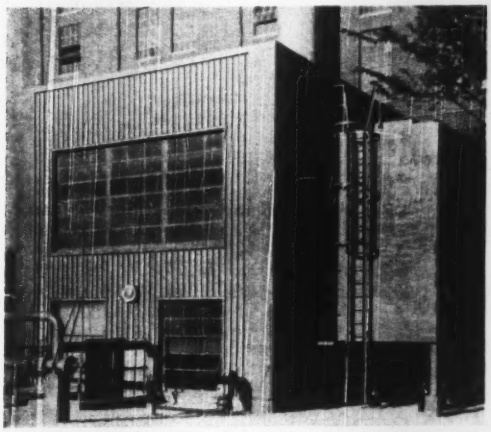

FIG. 5 AIR PRECOOLER LOCATED ON RIGHT-HAND SIDE OF BUILDING (Well water cools air, increasing unit capacity.)

in making the installation of the gas turbine-generator proper was longer than would normally be required since it was erected in conjunction with the construction of the building. This caused very slow progress, since at the start, work was being done in the open without crane facilities. In the future it should be possible to install a unit similar to this in less than 1 month, provided that the building and foundation are completed and a full-capacity crane is available.

Figs. 4 to 7, inclusive, show various internal and external views of the gas-turbine installation at Huey. The following data cover the period from the time the unit went into service on

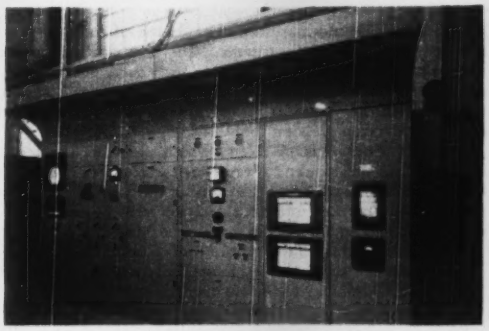

FIG. 6 CABINETROL WITH RECORDING INSTRUMENTS, INDICATING LIGHTS, AND CONTROLS FOR STARTING AND STOPPING UNIT

July 29, 1949, until it was taken out of service on February 6, 1950, for a general inspection:

Total hours in service	3912
Kwhr generated	15,486,000
Average load, kw	3959
Average exhaust temperature, deg F	776
Maximum load, kw	5000

The unit has been outstanding during this initial run due to the lack of unscheduled outages, and nothing developed during the run or was found during the recent inspection to prevent the unit from running indefinitely with little or no maintenance. Complete discussion of the operation of the unit has been published in the technical press.[4]

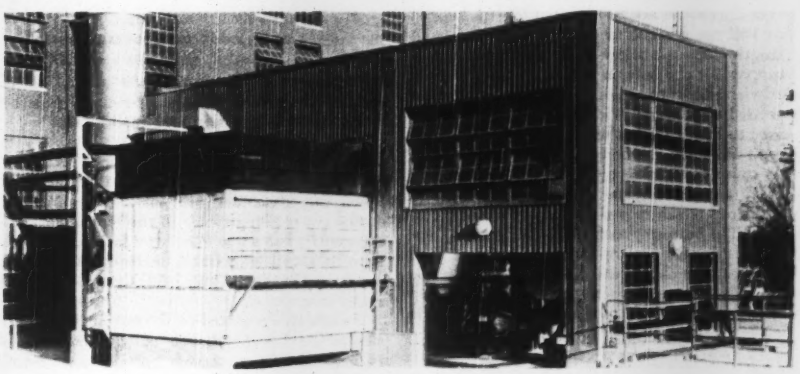

FIG. 7 OUTSIDE VIEW OF GAS-TURBINE BUILDING, SHOWING RECUPERATOR WHERE TURBINE EXHAUST GAS HEATS FEEDWATER

Considerations in DESIGNING TOOLS *for* POWDER METALLURGY

By IRVING J. DONAHUE

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PUBLISHED information on the design of tools to press powder-metal parts is meager. This situation may be due to a belief by manufacturers of such parts that the disclosure of design data would give their competitors access to secrets which they consider vitally important in the construction of production pressing tools.

Actually, there are many factors which enter into the design of tools which preclude any advantage of secrecy. No two parts have the same design, hence the pressing tools will be different in each case. Furthermore, consideration must be given to the type of powders and number of parts to be pressed.

Each has a bearing on the type of tool to be designed. If the part is small and simple in design and only a few pieces are to be pressed, the pressing tools also may be simple in design.

When the design of the part becomes complex, more thought must be given to the design of the pressing tools.

Just what information should the tool designer have before starting the layout of the pressing? Perhaps the first thought would be, can the part be pressed with equal density throughout its different sections? What kind of powders will be used to produce the part? What are the compressibility and apparent density of the powder? Will the part shrink or expand after sintering? What will be the pressing density of the part which may help to control the shrinkage or expansion of the finished part? These factors should be known so the die fill may be established to obtain the correct pressing density.

SEQUENCE OF PRESSING A SIMPLE BUSHING

Fig. 1 shows a die, core rod, top and bottom punches in the fill position and in the compressed position for making a simple straight bushing.

The die in the fill position has a powder compressibility ratio of 2 to 1 for a pressed bushing 1 in. long. With a compressibility of 2 to 1, the die will have a fill of 2 in.

The length of the die should not be less than $2^1/_2$ in. long or a ratio of $2^1/_2$ to 1 of the finished length of the pressed part. The additional length of the die below the fill position will act as a guide and support for the bottom punch.

The compressed view shows the position of the punches when the bushing is pressed to length. With a die fill of 2 in., and the bushing pressed to 1 in. length, the top punch moves down into the die $^1/_2$ in., and then the bottom punch moves up $^1/_2$ in., both punches compressing the powder to the 1 in. length.

After compressing the powder, the bottom punch remains stationary while the top punch moves up and out of the die to a clearance height. The bottom punch then starts moving upward, raising the bushing to the top of the die, where it is moved away by a sweep which fills the die with powder while the bottom punch moves down to its fill position. The sweep then moves away from the die cavity and another pressing cycle begins.

Contributed by the Production Engineering Division and presented at the Fall Meeting, Worcester, Mass., September 19-21, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

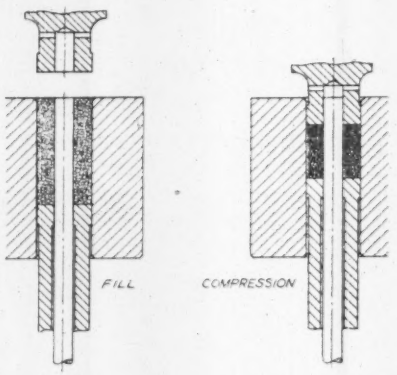

FIG. 1 DIE, CORE ROD, TOP AND BOTTOM PUNCHES IN FILL POSITION, AND IN COMPRESSED POSITION FOR MAKING A STRAIGHT BUSHING

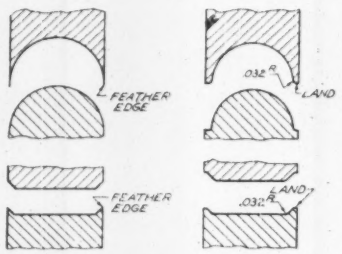

FIG. 2 PARTS WITH BEVEL OR RADIUS EDGE

The die cavity has a chamfer around its edges on both ends. This chamfer helps the punches to enter the die easily when the tools are assembled in the press and aligned for accuracy.

A vent hole is placed in the top punch near the top of the core-rod hole. This is to allow the air to escape which might otherwise create a vacuum if the air is trapped in the core-rod hole during the pressing cycle. If the vent hole is not placed in the top punch, and there is no way for the air to escape, punches with thin walls may crack, or the upward movement of the top punch out of the die may be delayed long enough to cause the sweep to strike it.

If a chamfer is placed on the outside diameter on the bottom side of the die, it will help to obtain a better seat in the die holder and help to prevent burrs around the edge due to improper handling.

When it is necessary to press parts with a chamfer or radius

on its edges, the bevel or radius should not be too large. Fig. 2 shows parts with a bevel or radius edge. Parts should be redesigned to prevent a feather edge on the punches which may break away, causing a ragged edge on the finished part.

The punches which form the bevel or radius should have a small land on the outside edge and a small radius at the bottom of the bevel where the bevel blends into the body of the punch. This will strengthen the punch and eliminate breakage of the outside edge.

When it is necessary to press parts having a flange on one end which is not larger than $1^1/_2$ times its hub diameter, a die with a fixed fill may be used as shown in Fig. 3. Here again the

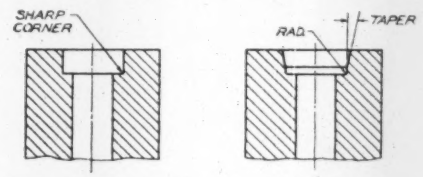

FIG. 3 DIES WITH FIXED FILL

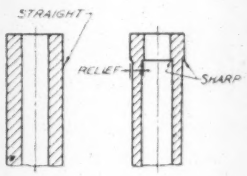

FIG. 4 SECTIONS OF BOTTOM PUNCHES

compressibility and apparent density of the powders is important to determine the depth of recess which forms the flange, so the flange will have the correct thickness and equal density throughout the entire part.

The two views show one with sharp corners at the bottom of recess and the other shows a better design. The sharp corners in the bottom of recess in the first view may cause the bottom edge of the flange to break away, owing to the bottom edge of the flange remaining in the die when the part is ejected. This may be caused by an undercut, rough corner, or too much friction on the straight sides of the recess.

In the view of the better design, the corner of the recess has a small radius and a 30-min taper with a straight side from the radius about $1^1/_2$ times the thickness of the pressed flange. In some cases, when the tolerance on the outside of the flange is not too critical, the taper can start at the radius. With this radius and taper there is less friction on this section of the die walls, enabling the part to be ejected from the die without broken edges.

At the bottom of the recess where the die forms the remaining section of the part, there should be a sharp corner or a minimum radius. When this edge has a large radius and the recess has a good depth, the powder during the filling cycle will move into the radius recess, and sometimes builds up enough resistance to prevent the bottom punch returning to the fill position.

If the edge has a sharp corner or minimum radius, the sharp corner will act as a wiper and will remove small particles of powder which may build up on the surface of the bottom punch.

Sections of a bottom punch, shown in Fig. 4, move up and down in the die. Two types of punches are shown, one with straight sides on the outside and inside diameters. The other view shows an improved design of bottom punch with sharp corners on the outside and inside diameters below the pressing surface. These sharp corners will act as wipers to remove small particles of powder which tend to build up on the die wall and core-rod surface, due sometimes to the different ingredients in the powder mix.

The punch should have a relief on the outside diameter and inside diameter of the core-rod hole about $^3/_8$ to $^1/_2$ in. below the pressing surface. This relief helps to cut down the friction on the die wall and core-rod surface. The top punch can also have the same construction.

VARIOUS TYPES OF CORE RODS AND HOLDERS

Various types of core rods and holders, which can be used when pressing different parts, are shown in Figs. 5 and 6. View A in Fig. 5 is the type of core rod which can be used for small and thin parts where the friction during ejection is not too great. Core rods of this type are generally made from drill rod or music wire.

When drill rod is used, only the area around the pressing section is hardened, and the remaining length is soft or drawn to a spring temper. Music wire can be used without hardening, and the pressing section flash-chromed to increase its wearing qualities.

The end opposite the pressing section is notched and when placed in holder F, Fig. 6, aligns with the setscrew which binds it in the holder. The notch should have a taper so the screw will bind on this taper, preventing the core rod from pulling out of the holder when the part is ejected from the die.

The core rod B, Fig. 5, is designed so that it can be reversed when one end wears below the pressing size. This type of core rod is hardened for its entire length and is made from various types of steel which will obtain a Rockwell hardness from C-58 to C-64.

One disadvantage of this type is the possibility of the core rod cracking around the tapped holes during hardening, unless precautions are taken when the core rod is quenched. The core rod is screwed onto the core-rod holder G, Fig. 6, and seats against the shoulder at the end of the threads. If the shoulder is not square with the threads, the core rod may not align with the center line of the die. This may cause the bottom punch to bind or the part to crack during the ejection operation.

The thread ends on core rod B are countersunk, and at least one thread removed, so core-rod holder G may have a radius at

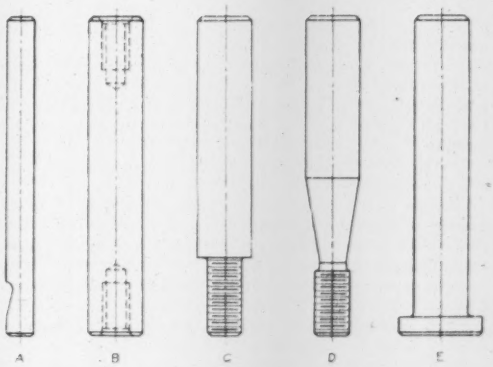

FIG. 5 TYPICAL CORE RODS

the end of thread where it unites with the body of the core-rod holder. This radius will add strength to this section of the holder.

Core rods C and D, Fig. 5, have external threads on opposite ends of the pressing section and are screwed into holder H, Fig. 6, and held in place by a setscrew.

It is sometimes good practice to use a core rod like D with a taper below the pressing section and above the threads. This

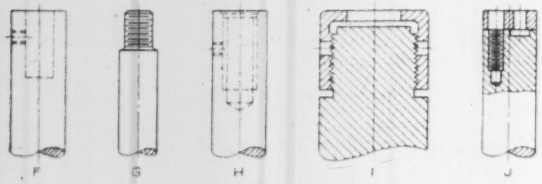

FIG. 6 TYPICAL CORE RODS AND HOLDERS

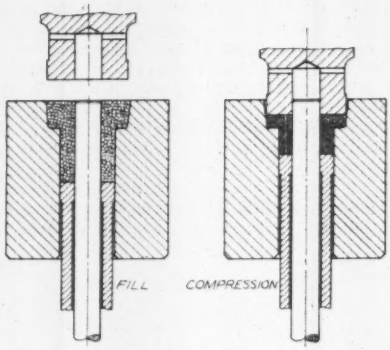

FIG. 7 DIE ASSEMBLY TO PRESS FLANGED BUSHINGS

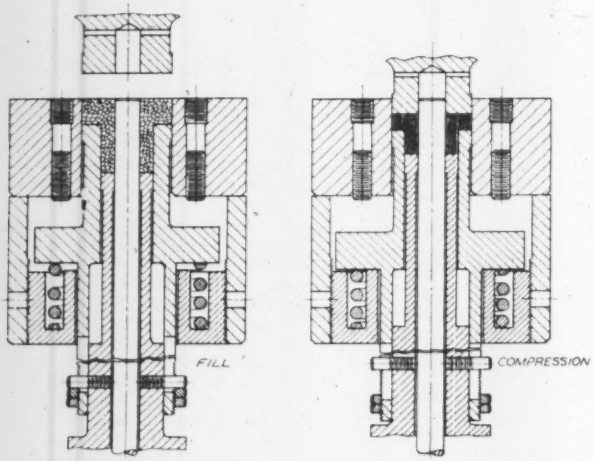

FIG. 8 DIE ASSEMBLY WITH SECONDARY PUNCH, ANVIL NUT, AND SPRING

will give the core rod a spring action and allow for a slight movement. The smallest diameter of the taper should not be less than the root diameter of the threaded section.

Both core rods are made from material that can be hardened to a Rockwell C-58 to C-64. The hardness depends on the powders that are to be pressed. Some powders require a core rod with a greater hardness than others owing to their abrasive qualities.

The thread end should be drawn to a lower Rockwell hardness or not hardened.

Core rod E, Fig. 5, and holders I and J, Fig. 6, have the advantage of easy changing when it is necessary to make several changes due to the abrasive action of the powders during pressing. This core rod may be hardened on the pressing section with its opposite end soft or drawn to a lower Rockwell hardness.

When it is possible to purchase standard-size material, a head or flange can be installed on the core rod by turning one end and making a small washer or collar with a countersink on one side of the hole. The washer can be secured to the core rod by welding around the turned section and the countersunk side of the washer, or it can be swaged over on the turned end around the countersunk hole and the end then refaced square with the body of the core rod.

DIE ASSEMBLIES TO PRESS FLANGED BUSHINGS

Fig. 7 shows a die assembly to press flanged bushings, with a flange not larger than $1^1/_2$ times the hub diameter. With the data for the compressibility and apparent density of the powders known, fixed fill can be calculated.

When bushings with flanges greater than $1^1/_2$ times the hub diameter are pressed, a more complicated die arrangement must be used, as in Fig. 8. In addition to the assembly, as in Fig. 7, a secondary punch, anvil nut, and spring are used.

The bottom punch pulls the secondary punch down to the fill position where it floats on top of the spring. It is held in this position by two pins attached to the bottom punch and can be adjusted by two nuts.

When the pressing cycle begins and the top punch enters the die and builds up enough pressure, the secondary punch moves

down to the anvil nut which also can be adjusted to obtain the correct thickness and density in the flange. During this pressing cycle, the bottom punch moves up to its compressive position where both punches press the bushing to its required length. After the top punch moves up and out of the die, the friction on the die wall of the flanged and hub sections hold the secondary punch against the anvil nut until the bottom punch begins to rise to eject the bushing.

At the same time, the springs help to raise the flanged section to the top of the table where it is stopped by two setscrews, allowing the bottom punch to continue raising the hub section to the top of the table, where the sweep moves it away from the die cavity.

This die assembly may be used for any number of different flanged designs which may include flanges with gear teeth. In most cases the setting for the fill position of the punches may be made before the assembly is placed in the press with little or no adjustment necessary after the first setting.

Space does not permit the showing of many other different tool designs which help to obtain the physicals that are required to produce a finished part.

Many of these designs include the use of springs in the top punches, dies, secondary punches, bottom punches, and core rods. Inserts to create a friction are also used to raise component parts in the die assembly.

DESIGN HINTS

Many dies have been designed with projections on top of the die table, also cutaways below the table surface, to obtain the required density on some section of the part to be pressed.

In many cases, the life of the dies has been prolonged by designing them with an additional section for the lubrication of the die.

It must be remembered that the cost of materials for tools is a small portion of the construction cost of such tools. If the design of the part is such that it is not necessary to make expensive tools, the additional cost of tools made from a better material will be so small that it may be more expensive to make tools from lower-grade materials.

Tools made from a lower-grade material may only prove that the part can be made and then only used for a small production, whereas, if the part is made successfully and repeat orders are received, it may mean delay in construction of new tools from a better-quality material.

When it is necessary to make dies with intricate design, the die could be split into two or more sections, each section roughed, hardened, and ground by shaping the grinding wheel to conform with the contour of the part. These sections are assembled, and the outside diameter ground and later shrunk into a holder made from a softer material.

It is good practice to make split dies from high-carbon high-chrome steel with a softer material for the holder. The high-carbon high-chrome steel, having a high-drawing temperature, will not be drawn to a lower hardness by the shrinking temperatures of the holder.

When designing pressing tools, it is good practice to standardize them as much as possible, especially where tools may be interchanged from one press to another, even though the pressing tonnages may vary.

To design tools to press parts from powder metals, the designer should obtain all the information and data possible from the quality-control engineer, the laboratory, pressing foreman, and toolroom foreman, before he decides on the design of the tool.

Considering each one of these factors as vitally important, the success or failure of the tools may depend on any one of them.

An Engineering Approach to Stabilized Prosperity

(*Continued from page 872*)

a contributor and beneficiary of a national economic program of stabilization under the slogan "parity." But it has progressively redefined parity to make it less and less a formula for economic adjustment of production to market needs and more and more a cloak for federal subsidy to farmers politically shielded from the need for constructive adjustment.

Labor has made some impressive declarations in favor of mutual adjustment of the several parts of the economic machine to each other in a working whole. While I was serving on the Council of Economic Advisers, union representatives presented a memorial urging that "the President through his Council of Economic Advisers should convene all groups immediately to establish an agreed-upon program which all management, labor, and agriculture will pursue." The proposed conference was to seek a comprehensive answer to the question: "What do we do to build and maintain on a long-term basis a permanent full-employment and full-production economy?" But in default of such a grandiose agency of universal settlement, they have not been willing to rely upon the less ambitious but functionally better-adapted devices of bilateral collective bargaining in good faith. They have not been willing "to bear the burden and heat of the day" so as to work out the kind of adjustment of productive input and wage "take" that would promote stabilized prosperity. They have conducted hundred-day strikes or used their mass power in other ways to exact unilateral decisions, some of which have demoralizing effects that are not hard to discover.

Management has been equally obdurate in clinging to past traditions or future aspirations even when the consequent shutdown strongly threatened to result in the government taking over the industry and possibly starting a chain reaction that would end in nationalization of a basic industry.

Government planners have been willing to follow reformist dogma to the point of making operative conditions difficult if not impossible for private business. And reactionary businessmen have sought to confine areas of public service to the limits which were appropriate to a preindustrial age. They have clamored for reduction in government spending and then put on political pressure to get themselves exempted from any act that adversely touched their company or their community. An engineering project could not run with that kind of sabotage, and neither can we stabilize national prosperity with that kind of individual and group action.

As yet the promise of the Employment Act has not been fulfilled. There has not been a willingness to weigh the claims of all special-interest groups as parts of a total productive program and to formulate and follow those policies that "on balance" will do most to promote the smooth functioning of the economy as a whole. Among our people the "gimme" spirit is rampant and the demand for personal security is put above the old spirit of personal creative achievement. Political agrarianism and political laborism have forged ahead of the political capitalism of the recent past, and the merger of farmer and laborer into an unbeatable coalition seems to be the pattern to which we are being adroitly led today.

It would be a sad commentary if, in this day when popular education has brought us such command of the technologies of material objects and natural forces, we should fail in our grasp of the technologies, that is the applied social science, of the human mind and spirit associated in business ventures and in free political life.

The RETURN *on* INVESTMENT

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INTRODUCTION

SUPPOSE one were offered a choice between receiving a net sum of $10,000 now or a net income of $1500 per year for the next 10 years. An intelligent decision can be made only after estimating the rate of return that reasonably could be expected if $10,000 were invested now, and whether such a return, together with the principal sum of $10,000, would provide more or less than $1500 per year for 10 years.

It is not generally recognized that this problem is similar to problems in which it is necessary to decide the most economical way, among several, of accomplishing a desired result, that is, with problems concerning cost studies which seek an answer to the following question: "Shall we spend more now in order to spend less later?" or, to repeat the question in another form, "Shall we spend more now in order to save more later?"

Cost studies of this type are usually solved by rough rules of thumb in which the extra investment (this term will be defined later) is divided by the reduction in expenses or prospective savings, in order to obtain a quantity called, variously: Years to pay off; years to pay out; pay-off period; pay-out period; years to return extra investment, etc.

The number of years thus obtained is used as a guide in recommending a choice among alternates. Pay-off periods of 2 to 15 years are common, depending upon the type of problem under consideration as well as the nature of the industry.

The solution of a problem by rule of thumb is justified only if the limitations inherent in such rules are understood, and if the fundamental theory from which the rules are derived is known. In general, the points concerning which many engineers are not too well informed are the following:

1 What items should enter into investment-cost estimates?

2 What items should enter into calculations of prospective savings or additions to profit?

3 What do pay-off periods really represent, and why can they be used to judge the desirability of one among several alternates?

The purpose of this paper is to answer these questions and in doing so to define a pay-off period which can be converted directly into a percentage figure comparable with interest rates, profit rates, and other measures of income such as yields on securities.

COST-COMPARISON STUDIES

The steps in solving problems in which cost comparisons are made, in order to decide on proposed expenditures, are somewhat as follows:

1 The alternates are clearly defined and all unnecessary alternates are deleted from the study. The problem of selecting the plans to which the study will be confined is an important one. Many studies err on the side of too many alternates. It is usually possible to pick the plan which will have the least investment cost, that which will have the highest investment cost, and any number of other plans for which investment costs will fall somewhere between the extreme values. Many of the alternates which obviously would have investment costs between the two extremes frequently can be eliminated.

Consider, for example, the choice of a new water supply for a plant in which nearly all of the water is used for cooling in closed-type heat-exchange equipment. At least two alternates are under consideration:

Alternate (a) Install a new city water line and waste to the sewer all the water used for cooling.

Alternate (b) Install a cooling tower and use city water for make-up only.

Many other alternates obviously could be considered. Should the cooling tower be forced draft or natural draft? Should the basin for the tower be designed to permit future expansion? All of these are secondary to the two alternates mentioned. If it is necessary to consider them at all, they might well be deferred to a later stage of the study.

2 After the alternates which will be studied further have been selected, one of them is chosen as a base with which the others are compared. This is usually the alternate giving the lowest investment cost.

3 Investment costs are estimated for each alternate.

4 The production costs, that is, the recurring items of yearly expense for labor, fuel, raw materials, and so forth, are estimated for each alternate. If any of the alternates calls for an expansion of capacity, net sales also must be estimated.

5 Investment costs and prospective savings are compared. The methods which are followed in making this comparison are the chief subject of this paper.

6 Before a decision is made, the intangible elements in the cost study are considered. In the problem mentioned, the growing concern with water shortages may swing the decision to alternate (*b*), although the yield on the extra investment required may not be attractive.

In order to simplify the discussion which follows, we will consider only problems in which the choice lies between two alternates. As indicated in step 2, if there are more than two alternates, one is selected as a base with which the others are compared, so that even a study involving many alternates can be broken down into a series of studies, each involving only two. The alternate selected as a base frequently requires no expenditure for new investment, that is, the decision lies between doing nothing or doing one of several things, which will increase profits by decreasing expenses, increasing sales, or both.

Furthermore, we will not consider intangibles, that is, we will assume that decisions can be made solely on the basis of cost.

TYPES OF COST STUDIES

Cost studies to determine what, if anything, should be done generally fall into two classes.

The first class represents studies in which there is no contemplated increase in existing or proposed plant capacity but where some investment has to be made in order to keep existing capacity, or place proposed capacity, in operation. In short, it is not necessary to estimate net sales.

Consider again the water-supply problem described pre-

Contributed by the Management Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 19–23, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

viously. Investment costs and yearly expenses are given in Table 1. The first alternate does not provide a cooling tower while the second alternate does.

TABLE 1 INVESTMENT COST AND YEARLY EXPENSES OF WATER-SUPPLY PROBLEM

	Initial investment cost	Yearly expenses
Alternate (*a*)	$ 4000	$9000
Alternate (*b*)	11000	6000

In this example, the extra investment in alternate (*b*) is $7000 ($11,000 minus $4000). However, this extra investment is offset by a reduction of $3000 ($9000 minus $6000) in yearly expenses.

The other class of problems involves changes in plant capacity, for example, Shall a new plant be built or not? For this type of problem, the extra investment obviously is the cost of new capacity, while the prospective profits are net sales less expenses.

If the cost study concerns a choice between doubling and trebling the capacity of an existing installation, the investment cost for alternate (*a*) is the cost of doubling capacity, and the investment cost for alternate (*b*) is the cost of trebling capacity. The extra investment is the difference between the investment costs for alternates (*b*) and (*a*). The prospective profit after taxes is obtained by estimating the net sales less expenses for alternate (*a*) and the net sales less expenses for alternate (*b*). The difference between net sales less expenses for alternates (*b*) and (*a*) gives the prospective profits for the extra investment in alternate (*b*).

INVESTMENT COSTS

For a new facility, money may be required for any or all of the following: Land, plant and equipment, working capital.

Land is a fixed asset. The value of land posted in the accounting records is its purchase price. This value is assumed to be fixed and, consequently, the investment in land is not depreciated. Nevertheless, if a business found it necessary to close down and sell its land, it may suffer a substantial loss, in spite of the fact that the life of land, for practical purposes, is infinite, and, therefore, that no depreciation expense is chargeable against its use. For this reason, the cost of land is often included in estimates of investment cost for calculations of the pay-off period, although, strictly speaking, only investments which are depreciable should be considered.

Investment costs for plant and equipment include the cost of equipment, building and other materials, and erection labor, as well as the cost of supervising construction, for engineering expenses in connection with specifications and drawings, and the like. In short, investment costs for plant and equipment include all the costs which would be amortized if the work were done.

Investment costs for the type of study we are discussing do not include working capital. Working capital represents liquid assets which presumably can be recovered at any time. Estimates of working-capital requirements must be considered in cost comparisons of the amount of money required for financing a given project. However, this type of comparison is not the subject of this paper.

As yet, we have not mentioned salvage value with regard to investment-cost estimates. The assumption of negligible salvage value is common to cost studies of the type we are discussing because any other assumption usually complicates matters without adding materially to the results obtained. However, there may be instances where salvage value is important and serious errors would result from neglecting it.

If it is not appropriate to neglect salvage value, an estimate of this value must be made for each of the alternates under consideration. The estimated salvage value is then deducted from the cost of new investment to obtain the investment cost for each alternate.

YEARLY EXPENSES

Every dollar of prospective sales and other income eventually will be distributed among the following expense and ownership accounts:

1 Expenses:
   - (*a*) Operating labor and supplies including raw materials.
   - (*b*) Maintenance labor and supplies.
   - (*c*) Administrative and selling expenses.
   - (*d*) Insurance and property taxes.
   - (*e*) Interest.

2 Depreciation.

3 Gross profit:
   - (*a*) Income taxes.
   - (*b*) Net profit.

The terminology used in the foregoing tabulation does not conform to strict accounting practice but will be useful for our purpose. All expenses except depreciation have been grouped under the heading "Expenses." The gross profit is total income less expenses and depreciation. The net profit is the gross profit less income taxes.

Interest has been included as an item of expense. If money has to be borrowed for the proposed investment, interest obviously is an expense. If money is not borrowed but is available from reserves, it is often included as an expense since the yield that could be obtained by investing it in securities or the reduction in interest payments that would result if existing debts were paid off would have to be sacrificed. A more realistic approach, however, is to accept things as they are. If money has to be borrowed, interest is an out-of-pocket expense. If it does not, interest is not an out-of-pocket expense.

For problems in which no change in capacity is involved, as in the water-supply problem discussed, the total income from sales and other sources is assumed to remain the same since it is not affected by the choice of alternate. Therefore any reduction in expenses will leave an equivalent sum to be distributed partly to depreciation, partly to income taxes, and partly to net profit.

If, for example, expenses would be reduced $3000 per year by installing a cooling tower for an extra investment of $7000, a sum of $3000 would be available annually for distribution among depreciation, income taxes, and net profit. For an estimated useful life of 10 years, the annual depreciation allowance is $700. The gross profit which will result from the extra investment is then $2300 ($3000 minus $700). Corporate income-tax rates are now about 40 per cent. Therefore the additional income tax which would have to be paid is about $900 (40 per cent of $2300) and the additional net profit earned by the extra investment for each of 10 years is $1400 ($2300 minus $900).

For problems in which capacity is changed, each dollar of new sales eventually would be distributed among expenses, depreciation, income taxes, and net profit. Thus, if new sales are estimated at $1,000,000, and annual expenses at $700,000, a sum of $300,000 is left for depreciation and gross profit. For a 10-year life and an investment cost of $1,000,000, depreciation expense is $100,000 per year, and estimated gross profit is $200,000 per year. Income taxes and net profit can then be estimated from the tax rates.

PAY-OFF PERIODS

Pay-off periods are obtained by dividing the extra investment either by the gross profit before depreciation or the net profit before depreciation.

For problems in which no change in capacity is involved, the reduction in expenses which would result if the extra investment were installed is, as explained previously, identical with the addition to gross profits before depreciation. For problems in which there is an increase of capacity, the gross profit before depreciation is given by net sales less expenses.

The pay-off period, based on gross profit for the water-supply problem, is thus

$$\frac{\$7000 \text{ (extra investment)}}{\$3000 \text{ (reduction in annual expenses)}} = 2\tfrac{1}{3} \text{ years}$$

Similarly, for the problem in which new capacity is to be provided, the pay-off period, based on gross profit, is

$$\frac{\$1{,}000{,}000 \text{ (investment)}}{\$1{,}000{,}000 \text{ (sales)} - \$700{,}000 \text{ (expenses)}} = \frac{\$1{,}000{,}000}{\$300{,}000} = 3\tfrac{1}{3} \text{ years.}$$

The justification for calculating pay-off periods, based on gross profit, can be explained most simply as follows: For the water-supply problem, the useful life has been estimated as 10 years. Suppose, however, that the tax authorities would allow a depreciation rate based on the pay-off period of $2\frac{1}{3}$ years. The reduction of expenses of $3000 per year, which would result from the extra investment, is then balanced by the increase in depreciation expense of $3000 per year ($7000 divided by $2\frac{1}{3}$ years), leaving nothing for additions to gross profit and, consequently, for additions to net profit and income taxes.

After the $2\frac{1}{3}$ years are over, there would still be an estimated reduction in expenses of $3000 but all of this sum would represent an addition to gross profit.

In short, for a useful life of 10 years, there would be no profit for $2\frac{1}{3}$ years and an increase in gross profit of $3000 for $7\frac{2}{3}$ years. The additional annual income tax for $7\frac{2}{3}$ years would be 40 per cent of $3000 or $1200, and the additional annual net profit for $7\frac{2}{3}$ years would be $1800. The total net profit over a period of 10 years would be about $14,000 ($1800 times $7\frac{2}{3}$ years) or, at an average rate of $1400 per year, which is identical with the value we obtained previously.

Actually, of course, the tax authorities would not permit depreciation to be carried at a rate based on the pay-off period. This does not mean that the foregoing method of calculating the pay-off period is wrong. It only means that no significance can be attached to a pay-off period which has been selected as a guide in evaluating an investment, unless there is definite information on whether it was based on gross profit before depreciation or net profit before depreciation.

For problems involving no change in capacity and for pay-off periods based on net profit before depreciation, it is necessary to estimate depreciation in order to arrive at the income tax, and then to deduct the income tax from the estimated reduction in expenses. This is so because, with no change in total income, the reduction in expenses due to a given extra investment less the increase in income tax which will result from that investment equals the net profit before depreciation.

For problems in which there is an increase in capacity, the net sales less expenses and income tax give the net profit before depreciation.

For the water-supply problem, the pay-off period, based upon net profit before depreciation, is

$$\frac{\$7000}{\$2100} = 3\tfrac{1}{3} \text{ years}$$

Here the denominator of $2100 equals the reduction in expenses for alternate (*b*) ($3000) less the estimated income tax of $900. This, of course, equals the estimated depreciation of $700 plus the estimated net profit of $1400.

For the problem on new capacity, the net profit before depreciation equals $120,000 (60 per cent of the gross profit of $200,000) plus $100,000 (depreciation) to give a total of $220,000. This quantity also equals sales ($1,000,000) less expenses ($700,000) less the income tax (40 per cent of $200,000 or $80,000).

The significance of pay-off periods based on net profit before depreciation is that they indicate the number of years the net profit obtained from the extra investment would have to be set aside in a reserve (rather than distributed as dividends) before the investment is recovered.

In the water-supply problem, for example, the pay-off period was $3\frac{1}{3}$ years. Depreciation is $700 per year. At the end of $3\frac{1}{3}$ years, depreciation charges would be equal to $2300 ($700 times $3\frac{1}{3}$ years). Of the total investment of $7000, a sum of $4700 ($7000 minus $2300) is still to be recovered.

If the net profit of $1400 per year due to the extra investment is set aside in a reserve for $3\frac{1}{3}$ years, the total reserve at the end of that time will be $4700. In other words, the pay-off period gives the number of years it will take to recover the proposed investment out of the profit after income taxes but before depreciation.

Pay-off periods, based on net profit before depreciation, are theoretically sounder than pay-off periods based on gross profit before depreciation and, as we shall see, are directly convertible into an interest rate.

There is one more comment on pay-off periods which is significant. Pay-off periods do not lend themselves well to cost studies in which the useful lives of the various alternates under consideration differ. Suppose, for example, we are comparing the transportation of materials by barge in one case and trucks in the other. The useful life of barges is on the order of 20 to 30 years, and the useful life of trucks is on the order of 3 to 4 years. It would be better to compare annual costs directly rather than to attempt a comparison by estimating a pay-off period. If the pay-off-period method were to be used at all, it would be necessary to select the alternate having the shortest life (in this case trucks) as a base. The investment cost for barges would then be the cost of new barges less the salvage value of the barges at the end of the useful life of the trucks.

STATEMENT OF THE PROBLEM

We are now in a position to state correctly the problems that arose in connection with furnishing a new water supply and increasing plant capacity.

Let us consider the water supply first. This problem is often stated as follows: "Shall we spend $7000 now in order to reduce expenses $3000 per year?"

It should be obvious from the foregoing discussion that this question is meaningless and that the correct statement is: "Shall we spend $7000 now in order to add an estimated $1400 annually to net profits for a period of ten years?" An alternative statement of the problem which has several advantages for our purpose is: "Shall we spend $7000 now in order to provide a sum of $2100 annually for the next 10 years of which $700 per year will be used to retire the investment and $1400 will represent an addition to net profits?"

Similarly, the problem on new plant capacity can be stated as follows: "Shall we spend $1,000,000 now in order to provide a sum of $220,000 per year for 10 years of which $100,000 will be

used to retire the investment and $120,000 will represent an addition to net profits?"

All of these statements can be summarized in the following form: "Shall we invest a sum of money P now if we can reasonably expect to receive annual payments R for a period of years (represented by the useful life of the investment), where these payments are large enough not only to recover the principal sum P but to give us a net profit?"

SOLUTION OF THE PROBLEM

The statement just given indicates that the general problem we are considering is analogous to a problem often encountered in connection with money. Suppose, for example, one were offered a net sum of $10,000 now or a net income of $1000 per year for 10 years.

Most people would prefer the $10,000 now even though $1000 per year for 10 years is equal to $10,000. This reasoning is based on the fact that $10,000 can be invested to earn a return so that more than $10,000 actually will be available over a period of 10 years. Furthermore, $10,000 now is usually more attractive than $10,000 over a period of years.

As mentioned in the introduction, if someone offered a net sum of $10,000 now or a net income of $1500 per year for the next 10 years, an intelligent choice can be made only after estimating the return one could reasonably expect, and whether such a return, together with the principal sum of $10,000, would provide more or less than $1500 per year for 10 years, with nothing remaining at the end of that time. If it provided less than $1500 per year, an annual income of $1500 for 10 years would be chosen. If it provided more, one would choose $10,000 now.

As a first guess, one might try a return of 6 per cent. For this interest rate, what sum of money could be withdrawn at the end of each year and have nothing in the bank at the end of 10 years? An approximate answer can be obtained as follows:

Reduction of principal	$10,000/10	$1000
Interest during first year	6% of $10,000 = $600	
Interest during last year	6% of $1,000 = 60	
Average interest during ten-year period	$660/2	330
	Total	$1330

The foregoing tabulation indicates that if $10,000 were invested at 6 per cent, one could withdraw $1330 per year for 10 years with nothing remaining at the end of that time. Therefore $1500 would be acceptable per year for 10 years rather than $10,000 now, assuming that one had no immediate need for a large sum of money.

Suppose, however, that one was able to invest $10,000 at 10 per cent interest. The amount that could be withdrawn each year for 10 years is given approximately by the following calculations:

Reduction of principal	$10,000/10	$1000
Interest during first year	10% of $10,000 = $1,000	
Interest during last year	10% of $1,000 = 100	
Average interest during 10-year period	$1100/2	550
	Total	$1550

On this basis, an annual income of $1500 does not look as attractive as receiving a flat sum of $10,000 now.

The exact solution of the problem is even simpler, providing a convenient set of bond tables is available. These tables include a factor F known as the capital-recovery factor (see Appendix) by which the principal sum P, in this case $10,000, is multiplied to obtain an amount R which can be withdrawn at the end of each year for a given number of years and at a given interest rate with nothing remaining at the end of that time.

For 6 per cent interest and 10 years, F equals 0.1359. The amount which can be withdrawn each year for 10 years is then $1359. This checks the value of $1330 obtained by the approximate method. Similarly, for 10 per cent interest, the capital-recovery factor is 0.1627 which gives an annual payment of $1627. This is also a check against the $1550 obtained previously.

It should be noted that the capital-recovery factor not only simplifies the calculations but gives a more accurate figure. The higher the interest rate, the less accurate the figures obtained from the approximate method.

In order to obtain exactly $1500 for 10 years with an investment of $10,000, the interest rate would have to be a little more than 8 per cent since the capital-recovery factor for this rate and a 10-year period is 0.1490, giving an annual payment of $1490 for 10 years.

In the water-supply problem discussed, the annual sum which was available each year for 10 years was $2100, including $700 for depreciation (recovery of principal) and $1400 for net profit (return or interest). Obviously, the problem of determining

TABLE 2 RATES OF RETURN EXPRESSED AS PERCENTAGES FOR PAY-OFF PERIODS OF 1/2 TO 100 YEARS AND USEFUL LIVES OF 1/2 TO 100 YEARS

Useful life in years	PAY-OFF PERIOD IN YEARS																							
	1/2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30	40	50	100	Infinity
1/2	0																										
1	106	0																									
2	176	62	0																								
3	188	83	25	0																							
4	195	92	36	13	0																						
5	198	97	41	20	8	0																					
6	200	99	45	24	13	5	0																				
7	200	100	47	27	16	9	4	0																			
8	200	100	48	29	19	12	7	3	0																		
9	200	100	49	30	20	14	9	5	2	0																	
10	200	100	49	31	21	15	11	7	4	2	0																
11	200	100	50	31	22	16	12	8	6	3	1	0															
12	200	100	50	32	23	17	13	9	7	4	2	1	0														
13	200	100	50	32	23	17	13	10	8	5	3	2	1	0													
14	200	100	50	33	23	17	14	10	8	6	4	3	2	1	0												
15	200	100	50	33	24	18	14	11	9	7	5	4	3	2	1	0											
16	200	100	50	33	24	18	14	11	9	7	6	5	4	3	2	1	0										
17	200	100	50	33	24	18	16	12	10	8	7	5	4	3	2	2	1	0									
18	200	100	50	33	24	19	15	12	10	8	7	6	5	4	3	2	1	1	0								
19	200	100	50	33	24	19	16	13	11	9	8	7	6	4	3	3	2	1	1	0							
20	200	100	50	33	25	19	16	13	11	9	8	7	6	5	4	3	3	2	1	1	0						
25	200	100	50	33	25	20	16	14	12	10	9	8	7	6	5	4	4	3	3	2	2	0					
30	200	100	50	33	25	20	17	14	12	10	9	8	7	6	6	5	5	4	4	3	3	1	0				
40	200	100	50	33	25	20	17	14	12	11	10	9	8	7	6	6	5	5	5	4	4	2	1	0			
50	200	100	50	33	25	20	17	14	12	11	10	9	8	8	7	6	6	5	5	5	4	3	2	1	0		
100	200	100	50	33	25	20	17	14	12	11	10	10	9	8	7	7	6	6	6	5	5	4	3	2	2	0	
Infinity	200	100	50	33	25	20	17	14	12	11	10	10	9	8	7	7	6	6	6	5	5	4	3	2.5	2	1	0

NEGATIVE RETURNS

the yield on this investment is identical in every respect with determining the yield to be obtained if $7000 were invested now and $2100 was withdrawn at the end of each year for 10 years with nothing left at the end of that time.

The interest return or yield can be obtained directly from Table 2. This table is entered along the top with the ratio of P/R (the pay-off period based on net profit before depreciation) and along the side with the number of years representing the useful life. In our example, the P/R ratio is about 3, and the useful life is 10 years. Therefore the extra investment of $7000 will earn a return of about 30 per cent over a 10-year period.

Table 2 also indicates that:

1 If the useful life equals the pay-off period, the return is zero. This, of course, is obvious.

2 If the useful life is less than the pay-off period, the return is negative, that is, there will be a loss on the extra investment.

3 For any given pay-off period, the rate of return rapidly approaches the value equivalent to a useful life of infinity. For a pay-off period of $^1/_2$ year, for example, the rate of return for a useful life of 6 years is 200 per cent or identical (to three significant figures) with the rate of return corresponding to a useful life of infinity.

Table 3 is an abstract of Table 2 which gives rates of return for common pay-off periods and useful lives.

TABLE 3 ABSTRACT OF TABLE 2

	Percentage rate of return		
Pay-off period, years	5-year life	10-year life	20-year life
1	97	100	100
2	41	49	50
3	20	31	33
4	8	21	25
5	0	15	19
10	(Negative)	0	8
15	(Negative)	(Negative)	3

A pay-off period of 5 years is thus equivalent to a yield of 15 per cent for a 10-year life expectancy. Similarly for a 20-year life expectancy the yield is 19 per cent.

Since it is common practice to underestimate the useful life in years, actual rates of return are usually higher than those indicated in Table 3. This, however, is not to say that high yields are unreasonable. A process installed now may have to compete in a few years with a much more economical process which can produce more cheaply and, therefore, the assumption that a given profit will be obtained over a 10 or 15-year life is unrealistic.

It is only by selecting alternates with low pay-off periods that industries, in which change is rapid, can assure themselves of recovering their principal before obsolescence of plant and equipment has overtaken them, and prospective profits are reduced by the more economic production of plants built subsequently.

CONCLUSION

The principal conclusions derived from this paper are as follows:

1 For cost studies of the type described herein the engineer-estimator responsible for the study should state clearly the assumptions on which the study is based. For example, has the cost of land been included in investment cost; has interest been included as an expense; is it appropriate to assume a negligible salvage value; on what basis have the estimates of useful life been made?

2 The pay-off period should be based on the net profit before depreciation and not on the gross profit before depreciation.

3 The pay-off period can be translated directly into a yield which can be compared with yield figures with which all are familiar, for example, yields on securities of various types. Actually it makes little difference whether the pay-off period or a percentage yield is used in making comparisons. It is often helpful to have both. The pay-off period is easily understood by those responsible for initiating investment. The yield is more easily understood by those responsible for raising the money required for investments.

Appendix

Let:

P = extra investment
R = net profit plus depreciation due to extra investment, or net sales less expenses and income tax
i = interest rate
n = useful life
F = capital-recovery factor

Then

$$\text{Pay-off period} = P/R$$

$$F = \frac{i(1+i)^n}{(1+i)^n - 1}$$

$$R = PF$$

$$P/R = 1/F = \frac{(1+i)^n - 1}{i(1+i)^n}$$

Financing Expansion

THE great growth and expansion which is characteristic of American business could never occur if it were not for the fact that American industry consistently follows the policy of "plowing-back" a large portion of earnings into business and thus financing business expansion to a large degree out of earnings, writes David R. Calhoun, Jr., president, St. Louis Union Trust Company, St. Louis, Mo., in *Chemical and Engineering News* for October 16, 1950.

This is illustrated[2] by a report which shows that for the years 1946, 1947, 1948, and the first half of 1949, business spent $52.3 billion on plant and equipment. Fifty-one per cent of this amount came from earnings plowed back into business. Thirty-four per cent came from depreciation charges. In other words, 85 per cent of the money for new plants and equipment came from internal sources—from plowed-back earnings and depreciation.

It is apparent that in the foreseeable future industry will be forced to depend mainly upon internal funds represented by retained earnings and depreciation charges in order to finance the expansion that must take place if we are to have a dynamic and expanding economy, Mr. Calhoun states. This requires a moderate dividend policy and this, in turn, makes common stocks less attractive for investment purposes because the dividends may be expected to be moderate in relation to earning power. There seems little likelihood that we shall ever see again the low rates of taxation that prevailed prior to World War II. Steeply graduated individual income taxes and death taxes, and high-rate corporation income taxes appear to be a permanent feature of our economy. Unless some relief is given in respect to the double taxation of dividends and to capital gains, Mr. Calhoun declares, it seems likely that the heavy tax burden required to finance the ever-expanding Social Welfare State, in conjunction with a tax structure and an incidence of taxation that penalizes enterprise, will result in the slow strangulation of our economy.

WHAT PROGRAM FOR ECPD?

The Chairman's Report to the Engineers' Council for Professional Development

By H. S. ROGERS

THIS report is written for all who have an interest in the work and achievements of the Engineers' Council for Professional Development, but more particularly for the interest and attention of the participating bodies with the hope that it may help their boards and officers to understand more clearly what ECPD is, should be, or should not be, and in what manner it is related to their separate and distinct programs and services to the great engineering profession.

The general objectives of our charter are broad enough to cover the particular interests of any member or group in the Council as representatives of our participating bodies. The "immediate objective" however, has been "the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself." Toward this objective the major efforts of ECPD have been directed throughout its life. To achieve this objective our committees have sought to improve the means for the induction, indoctrination, growth, development and recognition of their professional brothers.

ECPD AN INTERSOCIETY, INTRAPROFESSIONAL BODY

Under the charter the Council's operations were organized under four major committees on Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recognition. Within these areas all of the problems are more or less *intersociety* (common to our constituent members) and *intraprofessional* (within the profession of engineering). In contradistinction to this, the work of the Engineers Joint Council has been more or less *intersociety* and *extraprofessional*, dealing as it does with the relationships between engineers and industry, and between engineers and government.

The ECPD has been functioning in part in a staff capacity rendering *service to* and in part in an operating capacity as an *agent of* our constituent members. Our charter authorizes ECPD to study procedures within its objectives and recommend solutions. This is its staff function. The charter also authorizes ECPD to administer those programs specifically assigned to it by action of the supporting bodies. Two such programs have been intrusted to ECPD — the accrediting of engineering schools and the accrediting of technical institutes. They constitute our current operating function.

The societies also have authorized ECPD to organize cooperation in centers of engineering activity to facilitate the execution of its programs of student guidance and postcollege training, but until recently the programs themselves have not been prepared and authorized. The program on postcollege training is before the supporting societies as this report is being written.

To make constructive progress we must continue to point up our objectives more specifically, define our programs more purposefully, and organize our committees and their operations more definitely so as to give direction and continuity to their work. For success we also must have a better-informed interest and a more active participation in the work of the Council from our constituent membership.

During the past year the Executive Committee at each of its bimonthly meetings has designated the work of some standing committee as the special order of business and with the chosen committee has endeavored to get a clearer understanding of past accomplishments, to project a more definite program, and to adopt operating procedures for future accomplishments.

The chairmen of the committees have presented to you their annual reports at this meeting and these will be published in the record along with this report of mine, but I desire to make some comment upon each which, in some respects, may be entirely personal, but which I hope will have a bearing upon the thinking and work of the Council in the future.

STUDENT SELECTION AND GUIDANCE

The principal achievement of the Committee on Student Selection and Guidance has been the development, with the help of the Carnegie Foundation, of the Pre-Engineering Inventory, which was a useful instrument of substantial validity for the admission to and guidance of freshmen in engineering colleges. The development of the tests was, however, in very major part, originally financed by the Carnegie Foundation and might have been made by any one of a number of bodies dealing with psychological tests. The continuing revision, distribution, and scoring of the tests has been placed in the hands of the Educational Testing Service and they have endeavored to provide and score tests under a schedule of charges made upon those engineering schools or other groups who might use them. There has not, however, been enough interest upon the part of engineering schools throughout the country to place the project upon a stable self-supporting basis, and the Council therefore has endeavored to stimulate the interest of the engineering schools in co-operation with the American Society for Engineering Education. It is becoming apparent that enough schools either do not want, or cannot use, this service to make it self-supporting.

These results therefore present a major question of policy which is: "Should the Council endeavor to render a service in an area which lies almost wholly within the field of operations of only one of our constituent members?" "Should not this testing program, in so far as it is related to selection, be turned over to the engineering schools and the ASEE?" If the answer is "Yes," what then remains of a needed program in the area of selection and guidance?

It seems to your Chairman that the program of this committee should lie primarily in the field of guidance. Here the engineering schools, the high schools of the community, and many other agencies dealing with educational and professional guidance, need the help, the knowledge, and the inspiration of active members in the engineering profession, and the committee should launch upon a program of collaborating with and aiding all guidance agencies concerned ith wthe entrance of high-school graduates into engineering schools. Various

Presented at the 18th Annual Meeting, Cleveland, Ohio, Oct. 20–21, 1950, of The Engineers' Council for Professional Development.

engineering organizations are currently doing a great deal of work of this nature and a survey of such work was completed during the year. A review of this survey will reveal a picture of great need and opportunity for professional engineers to make a contribution toward the effectiveness of the work. Here is a task which the Council should organize to attack more effectively as an agent of its members.

ENGINEERING SCHOOLS

The achievement of the Committee on Engineering Schools is best known of all the work in the history of the Council. It has been a creditable, worthy, and constructive achievement. It has been made possible by the devoted service of many engineers throughout the entire country. It is a work of distinction and value with momentum and stability, and a future of continued distinction. The charter of ECPD, however, provides that the Committee on Engineering Schools shall report "means for bringing about co-operation between the engineering profession and the engineering schools." If we are to fulfill these broad objectives, we must recognize that area of relationships between the schools and the societies through the student chapters at our institutions and the relationships between the schools and industry. Some of our constituent members have been concerned with the problem created by the multiplicity of representative groups being organized on our campuses. They have participated in conferences with others to find some approach to the problems involved. Is not this an area in which the Council should serve its members? In the other broad area of relationships between the engineering schools and industry the Council should at least collaborate in a service which needs more definitive outline.

The task of accreditation is so great that it seems unwise to expect the Committee on Engineering Schools to undertake these broader educational relationships and it may be wise to establish a separate committee to attack these specific problems.

PROFESSIONAL TRAINING

The Committee on Professional Training is presenting at this annual meeting a comprehensive and sound basis for a constructive program which the Council is proposing we undertake as the agent of our membership. Its outline and description will be so fully presented that there is no need for elaboration here. Our membership, however, will recognize in it a great challenge, and their answer to it will determine the scope of the council's operations in the future.

If we really want to undertake a constructive work in the training and development of junior engineers of intersociety significance, then we must get behind this project. The Council and the Committee will make every effort to obtain substantial support for its operation as outlined, but our constituent membership must also contribute to its support. If we can make no substantial progress under this program we may then find it necessary to confine our efforts to such tasks as revising book lists and publishing articles and manuals of interest to young engineers. Co-operation in this project would therefore appear to be a test of how earnest our members are in subscribing to the objectives of ECPD.

PROFESSIONAL RECOGNITION

The Committee on Professional Recognition has focused its attention primarily upon standardization of grades of membership within our professional societies. We have made some progress in the adoption of standard grades, but there is still reluctance to make its adoption unanimous. There are other areas in which this Committee may render a service to our constituent members such as the promotion of the uniform registration laws and the clarification of professional degrees. I trust that the Council will be able to render constructive service in the promotion of sound policies and procedures in these fields.

Any achievement toward the improvement of conditions in these fields, however, must be made primarily by one or more of our constituent bodies and the work of our Committee must be primarily in the nature of promotion.

In summary, I have endeavored to emphasize the work of the Council as an intersociety, intraprofessional task, undertaken sometimes as a service to, and other times as an agent of, our constituent members. I do not think it is important to determine in what measure we shall render service to, or be agent of, our group, but I do think it most important that we define our undertakings more clearly and specifically; that the programs of our committee have sharper focus and continuity; and that we organize internally and co-operatively to produce more tangible and constructive achievements.

There are areas in which the program suggested for the future such as the relationships between engineering schools, and industry and the promotion of uniform registration laws, would need to be tackled in collaboration with our constituent members. The Founder Societies all have standing committees of one nature or another dealing with some of these problems. Unity and co-ordination in their solution holds forth the possibility of much saving in time and effort. The procedures, however, necessary to achieve this unity, will have to be worked out by committees assigned to the task.

In the consideration of this report and of the reports of the committees which accompany it, our constituent members are definitely confronted with the questions: "Do you want this kind of an ECPD?" "Are you willing to provide for it financially—with money, and to supply it with strong representation—with men?"

Executive Development

THE increasing complexities of business have created a corresponding demand for an increased education of executives, Dr. Ernest B. Dale, assistant professor of economics and industrial relations at Columbia University, New York, N. Y., told engineers at a recent meeting of the American Institute of Chemical Engineers held in Minneapolis, Minn. Dr. Dale stressed the importance of mutual assistance between industry and educators to produce the executives of tomorrow. Self-analysis, he said, is required to maximize the utilization of one's resources. Self-analysis enables abilities to be divided into the following three types: The first is all-round ability possessed by a man who can run a plant, has inventive traits, is interested in the business side, and gets along well with people. Second is the man who has fairly wide technical competence in a specific field. He can work with other engineers and gets along with factory foreman, but may have little or no ability for union, personnel, or manufacturing work. The third type has "pin-pointed" ability—the man who makes a major contribution to basic patents.

The importance of self-study and self-development must not be overlooked. Dr. Dale said that any management technique which has the basis of recognized status of science might well be acquired partially at least at a college or university. The need of university training for a large proportion of executives is essential. The need for consultations of practicing executives with potential executives to inform them of job prospects and to direct them into the right careers was outlined by Dr. Dale as the contribution industry should make.

Dr. Dale concluded that the main task of the universities will continue to be the advancement of knowledge.

STANDARDS *for* CITIZENSHIP

The Roy V. Wright Memorial Lecture

By ARTHUR T. VANDERBILT

CHIEF JUSTICE, SUPREME COURT OF NEW JERSEY, NEWARK, N. J

I COME here tonight in the name of friendship. Roy V. Wright had a great capacity for friendship, active, helpful friendship with many different kinds of men. One reason for that was that he was a man—one of the relatively few men—who did his duty in every field of life and not merely in one narrow specialty.

In his own special work as an editor, none stood higher. He recognized his duty to his profession and gave it an extraordinary year of activity as the president of this Society, but he didn't stop with that high honor; he continued to serve it in various capacities, not the least important of which was as the promoter and the chairman of the ASME Engineers' Civic Responsibility Committee. He was equally active in his community, in his church, in the Y.M.C.A., in the work of the local hospital of which he was president, and in a dozen other ways. In addition to all this he was active for many years in politics, first, as a member of the governing body of Essex County, New Jersey, one of the dozen largest counties in the nation; then, as a member of the Republican State Committee; and, finally, as a member of the State Senate.

For busy professional men, pressed with heavy responsibilities, many of which cannot be delegated, the inevitable tasks of political activity in a democratic society with free competition in politics as well as in enterprise are bound not only to be time-consuming, but to be thoroughly irksome. Nobody but a thoroughly good citizen such as Roy Wright was would ever take the pains or spend the time that is required in politics the way he did for years. But he did not stop here; he loved to work with young engineers, and so for many years he held the instructorship in civics and government at the Newark College of Engineering. The work culminated in the preparation, along with Mrs. Wright, and the publication of "How to Be a Responsible Citizen." After reading a score of books in that field, I still think theirs is by all odds the best.

It is peculiar pleasure for an erstwhile lawyer now removed to the seclusion of the bench to come to address a body of engineers, because I know, contrary to the general opinion among the profession, that the engineers have been among the first to awake to a growing sense of their responsibility as citizens. I consider the report published in 1944 by the Society for the Promotion of Engineering Education to be one of the greatest educational documents in American history. At a conference, held at Buck Hill Falls two years ago and sponsored by the Carnegie Corporation, of leading educators from the five professions of business, divinity, engineering, law, and medicine—a strange group some of you will think—it was the engineers and the divines who showed, at least in my opinion formulated after a quarter of a century of participation in politics, any real conception of what is expected of us today as citizens. I don't know whether it would be true of lawyers as a whole, but the professors of law who attended the conference were as unwilling to face not only the realities but the ideals of political life quite as much as the educators in business and medicine. For this neglect, can there be any doubt that business—and through business the whole country—has been paying the penalty for the last quarter to a half century? And is it not equally obvious that the default of the medical profession to see and do its duty as citizens is at least responsible for the specter of socialized medicine which is sending the shivers up and down the medical spine?

We often speak of this as an age of science. Half a century ago many good people were very much troubled over the apparent conflict between science and religion. All too many people have resolved that conflict by forgetting religion. Then we began to speak of the times as the age of technology, the age of mass production. The emphasis was on the satisfaction of material wants. As Emerson put it a century ago:

> Things are in the saddle
> And ride mankind.

But such designations of our age are grossly superficial. This is not the age of science; this is not the age of technology; this is not the age of mass production; this is not even the age of atomic energy or the atomic bomb.

Like it or not, we must each of us sooner or later face up to the fact that this is an age of politics, and in many parts of the world the age of power politics. In every continent except ours you will find dictators struggling to suppress democracy. Even here government has taken over large areas of activity undreamed of a quarter of a century ago. You get four very definite reminders of this a year from the Collector of Internal Revenue and I know not how many times from state and local authorities. This is an age of power politics, because people no longer think of government as an institution to live under, an institution that will protect them from force and violence at home or abroad and give them the opportunity to live, to work, to play, and to prosper. On the contrary, many people now look on government as an institution to live on. The growth of government employment in America is something that should claim your attention. According to a study by Fabricant, published by the Falk Foundation, in 1900, there was one person out of 28 on the public payroll (I am not taking into consideration the millions of people who are being paid either to raise or not to raise something); in 1920 there was one out of every 15 on the public payroll; in 1940 there was one out of every 11; and in 1948 there was one out of every 8. Every engineer, I am sure, has the statistical ability to plot the curve and tell us the exact year in which everybody will be on the public payroll. The only question that will remain to be solved in that millennium is who will make the money to meet the public payroll

Delivered at the inauguration of the Roy V. Wright Lectureship, under the auspices of the Engineers' Civic Responsibility Committee, at the Annual Meeting, Nov. 27-Dec. 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The Roy V. Wright Lecture was established as a tribute to Dr. Wright's participation as a citizen in the affairs of his community and in recognition of the stimulus his speeches and leadership gave to participation by all engineers in civic affairs.

Dr. Wright was a past-president and Honorary Member of ASME, and until his death the active leader of the ASME Engineers' Civic Responsibility Committee.—EDITOR

that we shall all be on, for it is notorious that governments do not make money, they merely spend it, and the most we can hope is that they spend it wisely.

This perennial reaching out of government is almost as grave a danger as the international threat that faces us on almost every continent. But with all of these involvements at home and abroad we face what seems to me to be an even more sinister phenomenon in our own domestic life. I personally do not like to have statistics thrown at me, and I shall not indulge excessively, but three figures tell the story of what is happening to us by our own volition. In 1940 only 59.5 per cent of our eligible voters took the trouble to go to the polls to vote for the next president. In 1944 the percentage had dropped to 56.4 per cent. In 1948 it had again dropped to 51.2 per cent. If this curve continues, it is plain that in 1952 we shall elect our president, a ruler with greater powers than any other in the world, by a majority of a minority of the eligible voters. This default not even to take the trouble to vote was dramatically illustrated in the Congressional elections. In 1938, thirty-eight million people voted for members of Congress, but in 1942, when we were well in World War II, eleven months after Pearl Harbor, the number of citizens who voted for members of the Congress that was to wage the war and perhaps dictate the peace dropped from 38 million to 28 million. Compare, if you will, these shameful figures with the recent election in Italy where 93 per cent of the people voted, or the still more recent election in Austria where 95 per cent of the people voted. I hope it is not true that we need to be deprived of our liberty as the citizens of these other countries were to make us recognize the practical worth to us of the great privilege of voting. Our failure to vote is, of course, just a symptom of the disease which has many other unhappy manifestations. A nationwide poll made not so long ago revealed that 67 per cent of the people answering a questionnaire said they would not like to have their sons go into politics, and 50 per cent of all the people said that a man could not go into politics and remain honest. Think of that! Of course, there are dishonest politicians just as there are dishonest businessmen, but no one suggests that we should not go into business because some businessmen are faithless. After a quarter of a century or more of political activity, I have the firm conviction that the percentage of dishonest politicians is no greater than the percentage of dishonest businessmen, or dishonest labor leaders, or dishonest anything else. How are we to run a democratic representative system of government if good people are too good for public affairs?

I cannot deny that politics may be a mean game. I have known what it is to be subjected to public attacks which everyone knew were absolutely untrue. It is very disagreeable; it makes a man of integrity very angry. But as I see it, we have the alternative of either doing our share year to year, month to month, and week to week in this disagreeable game of politics or every quarter of a century or less sending our sons—and it may well be next time our daughters—into the frightful ordeal of total war, not to mention imposing on our children and our grandchildren and their children in turn a staggering national debt which it seems almost impossible ever to meet. For any sane man or woman there can be no question as to what the choice will be.

And yet the fact is that most men shrink from running for public office. Very often their employers discourage them. Still more often the women of the household dread the inevitable rough and tumble to which the head of the house will be exposed. I know something about this at firsthand, for my chief political job over many years was to persuade men to run for office. They never ran any risk of being defeated. If they ran on our ticket, they were sure to be elected. They weren't called upon to put up big campaign contributions. All they had to do was to run; but all too often the little woman back home would say no, and that would be the end of the participation in politics of an otherwise desirable citizen.

Now that I am completely out of politics I am going to tell you something that I have never revealed before. I am going to tell you how I learned as a matter of sad experience to overcome the opposition of the ladies. When we wanted a man to run, we would have the right committee wait on him, not at his office, not at the club, but at his home with his wife present. When the good lady begins to hesitate, you just ask her, "Won't you pray over it?" No woman can ever turn you down on that. Then the next step is to ask, "Why shouldn't we pray right now?" If you can get them to pray right on the spot and make your appeal a very personal one, you will find that there are very few women who have the courage to turn God down. It is a very good system and I commend it to you all.

Another great difficulty, of course, emanates from the dislike of many corporations to having their employees and junior executives in politics. In fact, there are a great many corporations which like to have their lawyers, their engineers, and their accountants in firms which have both Republicans and Democrats so that they will always have a friend in the ruling camp. Either the total opposition of corporations to their men getting into politics or their efforts to play a bipartisan game tend to destroy sound government, and sooner or later they will come to realize it.

You may think the situation that I am describing is something of recent growth. Not so at all. *Fortune* ran a survey some years ago of the 67,000 graduates of the twelve leading preparatory schools in the United States. Some of these schools had histories running back for a century or two. Out of that tremendous number of picked men there was but one president, one justice of the United States Supreme Court, and 27 senators. For all too long our best brains have been going into business, into science, and into the law, and neglecting politics. When the article I refer to appeared, it so aroused the president of one of the New England colleges, who was speaking at one of the very preparatory schools involved, that he asserted that one could not go into politics and be a gentleman, as if that were the end of it all. Now really, I suppose if we are called upon to choose between being a good citizen and what he called being a gentleman, all of us would prefer to be good citizens. It is much more essential to the welfare of the country and to the continued existence of our children and grandchildren. Well, there you have the problem—a world in turmoil, the men who should be our public leaders uninterested in government and politics, and our citizens when they do vote not always voting intelligently.

When I moved out 25 years ago to the little town in Essex County where I now live, a town which prides itself on its intelligence, one of my friends, a Princeton graduate and a Harvard Law School man at that, called me up and said, "We are having an election for the school board next week and I hope you are going to vote." "Yes," I said, "I expect to." "Everybody up here is voting for Nos. 1, 3, and 5 on the ballot." "Tell me," I said, "who are 1, 3, and 5, and who are 2, 4, and 6, and also No. 7, if there is a No. 7?" I could feel the temperature dropping to the freezing point. "Do you have to be as legalistic at home," my neighbor said, "as you are down at the office?" And when I tell you that one of the men running in the election in which I was being asked to vote blindly was Dr. Frank B. Jewett of the Bell Telephone Laboratories, one of the greatest engineers of our times, you will see how important it was that I should know whether he was 1, 3, or 5, or 2, 4, or 6 before I voted, and I insist that I was not being legalistic merely because I wanted to know who the candidates were.

Many years ago I went to a political meeting in Montclair,

where I was asked to pinch-hit for a speaker while we were awaiting the arrival of Dwight W. Morrow, who was campaigning for United States Senator. Not being a trained political speaker, I suggested that we would play a game. If you want to become the most unpopular man in your town, I suggest that you play this same game and I will guarantee you results. There was my audience of 300 or 400 Republican county committeemen and women, the Republican members of the election boards, the presidents and other officers of innumerable Republican Clubs of Montclair, the Montclair that likes to call itself "the Athens of America." "Raise your right hand," I said, "and then drop it when you can't answer a question. At the end I will test to see that you know the answers that you claim to know when you keep your hand up." All raised their hands. "Who is the President of the United States? the Vice-President? the two United States Senators?—remember, there are two." Hands began to fall. "And who is your Congressman, not any Congressman but your own Congressman? and your Governor? and your State Senator? and your twelve Assemblymen?" By this time there were just a few hands left. "And your nine Freeholders? and the County Clerk? etc." Finally I said, "And who are the five Commissioners who govern Montclair?" At the end there were only two hands up in the entire audience! All the rest did not know even the names of the people for whom they had voted, not to say anything about their character and capacity for the things they were supposed to do. It was really quite shocking. Imagine how the ordinary citizenry of Montclair would make out if these active politicians in my audience did not know the answers; and if Montclair, what about all the rest of the United States? It is no easy job, is it, to be an intelligent voter?

And how difficult it is to vote honestly! In the diary of John Burroughs, the naturalist, who was probably as honest a man as ever lived, you will find this note on the day after the presidential election in 1912: "Woodrow Wilson won. It might have been worse; it might have been Taft. Voted for T.R. out of friendship—something he would never have done for anyone." Now, here you have an honest man admitting that he cast his vote for the presidency, not on the basis of who was the best man for the office, but on the basis of personal friendship. How can we ever hope for sound government if we vote for a man simply because he has the best profile, or wears the best clothes, or has the best voice, or the best Harvard accent, or the best anything else other than the capacity to be the best officer?

Now, when you think of all of the parasites who vote, not for friendship, but because of a job given to the family or the promise of some post that they may never get or because they think it best suits their individual pocketbooks, you will realize how far we have got to go before we will have achieved the first fundamentals of good citizenship. Indeed, not until men and women go into the voting booth and exercise their franchise with the honesty and intelligence that they would exercise as jurymen or women charged with the passing upon some defendant's life, can we hope for good government.

I have mentioned jury duty. I should hesitate to repeat my performance in Montclair by asking all who have ever asked to be excused from jury service to raise their hands. I really don't care to lose friends everywhere, but jury service is one of the few things that the state asks of us in peacetime beyond voting, and its proper exercise is essential to an honest administration of justice. Here is a field which requires almost as much improvement as that which I have indicated is needed in the selection of our public officials. There is almost no limit to the devices and the stratagems to which the ordinary citizen will resort to evade his duty to act as a juror. And yet we must all realize that the honest administration of justice, the very issue of liberty and life on the one hand and the safety of society on the other depend on the performance by the average citizen of his duty as a juror.

Our country really asks very little of us in voting and in jury service and yet if we do not attend to these fundamental responsibilities, we may be very sure that we are helping to bring on the day when the state will ask of us the ultimate duty of military service, which no one may refuse. Not only will the command come to us, but to the younger generation, a command that might have been escaped if each and every one of us had done his full duty in peacetime as a citizen. A man may be just as patriotic in peacetime as in war, though strangely enough we have a tendency always to think of patriotism as exclusively a wartime virtue.

I have dwelt on some of the fundamental responsibilities of citizenship: honest, intelligent voting; jury duty, an absolute essential to the administration of justice in this country; and military service in time of crisis. In addition to all of these official duties, however, each of us has an equally important unofficial duty as a citizen.

Ours is a country that is run in the last analysis by public opinion. If we are to really do our full duty as citizens, we must be ready year in and year out to play our part in the molding of public opinion. Let me give you an example or two of what I have in mind. I happened to be in London in February, 1938, the day after Anthony Eden resigned from the Cabinet in protest against Neville Chamberlain's policies of appeasement. I happened to have lunch with five judges of the House of Lords, the highest court in England. They quite frankly explained to me the meaning of Mr. Eden's resignation, and I equally frankly asked them why they had not listened to Charles Lindbergh, who earlier that month had said in the English press on his return from Germany that he had seen 30,000 warplanes there. Now, whatever may be Mr. Lindbergh's shortcomings as a politician and a statesman—and I think they are serious—he at least is a good aviator and he surely could recognize warplanes when he saw them. And yet the English practically threw him out of the country because, as the judges said, "Our people want peace and they don't want to have anybody telling them about warplanes in Germany. Our people just don't want to know how many planes the Germans have." And so for a year and a half, instead of preparing themselves to meet the 30,000 warplanes, the English did nothing.

We do not have to go abroad to find similar examples of failure of public opinion to meet its responsibilities. Back in October, 1937, President Roosevelt made a very courageous speech in Chicago, popularly known as the Japanese Quarantine Speech. That was nearly two years before World War II started and well over four years before we went into the war. The chances are that if we had heeded that speech, World War II might have been avoided or at least confined to the European area, but the fact is that practically every newspaper in the United States, Democratic and Republican alike, accused the President of being a warmonger. We had no intelligent public opinion in the United States in the realm of international affairs to back him up at that time. Consequently his ideas on this subject died aborning and the road for Pearl Harbor was prepared. The attitude of those carefree but unfortunate days was reflected in a bit of verse I saw in a college newspaper:

> The cow is in the cornfield,
> The cat is in the lake,
> The baby is in the ashcan,
> What difference does it make?

Well, as you can see as engineers, it makes a lot of difference. The cow, if it ate enough corn, would die. The cat in the lake would spell pollution to the waters. Somebody would cer-

tainly feel very badly if anything happened to the baby in the ashcan. And yet we were all saying in those days. "What difference does it make?" That was the spirit of the times and it brought us to a very sad pass. Accordingly, I have no hesitancy in saying that our great unofficial duty as citizens as the molders of public opinion is fully as important as our duty to vote, to act on juries, and to render military service if called on.

Everywhere we turn abroad we are faced with problems that seem to be almost beyond solution. Difficult as these problems are, I am more concerned with what is going on in our midst. The Director of the Federal Bureau of Investigation, Mr. J. Edgar Hoover, tells us that there is a serious act of violence committed in the United States every twenty minutes, but he adds that this is insignificant when compared with what communism is doing to us, especially in our labor unions. These are matters wherein we should bring the force of our influence to bear on public opinion. Equally deplorable is the steady drift year after year of government away from the states and toward Washington, away from the localities where citizens live to the state capital. The constant tendency in government seems to be toward centralization, and centralization inevitably spells bureaucracy. We are becoming so accustomed to the high cost of government that we regard it as normal. Last July the President in his annual message on the economic state of the Union said, "One of the things we must do is to increase inheritance taxes." I can't help but think of an estate of thirty-six million dollars, where I represented one of the parties in interest. The will provided for specific legacies of four and a half million. Then the testator gave all of the rest, residue, and remainder of the estate to his wife. The question that I want to put up to you is how much did she get out of the thirty-six million dollars after inheritance taxes and specific legacies were paid? The answer is less than one-half million dollars, and yet the President suggests that inheritance taxes are not enough!

I will not say anything about income taxes, but I am wondering constantly why someone doesn't rise up and say. "The war is over, let's get back to peacetime taxes," but no—all of us are taking wartime taxes as the customary thing for peacetime. That is the great danger of war, that its dictatorial powers will be perpetuated in time of peace.

I have indicated some of the main problems which confront the average citizen. I can hear many people say, "We haven't got the time! We haven't got the time! We are all so busy getting started. We are all so busy running some corporation that we are the head of or getting ready to be the head of that we just haven't got time to think of our duties as citizens." Well, if we were but willing to give up our many secular holidays to the work of citizenship, we would have more time for that purpose than we would know what to do with. It would be interesting for each and every one of us to jot down in the course of a year just how many days, or hours, or minutes each of us gives to his duties as a citizen. I warrant for the average man it would be less than an hour in the course of a year, and for many much less than that. We have neglected our birthright. Indeed, many of us seem to have failed to recognize what it really is—freedom, greater than has been known anywhere else in the civilized world or anywhere else in the pages of recorded history.

> Of what avail the plow or sail,
> Or land or life,
> If freedom fail?

The only thing that is going to stop freedom from failing in this country is the attention of every man and woman, especially those who have the intelligence and character to be leaders, to performing his or her duties as a citizen.

Purpose of Education

EDUCATION is preparation for life. Our assignment is clearly to study the means by which our students may best be prepared for life as well as for professional accomplishment. In attempting such a study we face the fact that our students today must wrestle with accumulations of knowledge and with complexities in the task of making a living far greater than those of their predecessors. Not only must they be trained for a vocation, but they must be made to recognize that the growth of science and technology has a profound impact on society at large.

It is possible for men to have no interests or competence outside of their profession. Such men are not well-rounded individuals. The first objective of education is to develop in students a sense of values in order that they may have those qualities—wisdom, judgment, tolerance, independence of thought, and critical sense—that mark an educated man. Each student must be prepared to accept individual responsibility for leadership in his profession, his neighborhood, and his nation; this implies his acceptance of the moral and ethical burden relating not only to his own acts but to the acts of the society of which he is a part. The ideal of individual responsibility implies a knowledge of the humanities, the social sciences, the physical sciences, and technology, arrived at intelligently and objectively. It implies cultivation of the spirit of free inquiry and rejection of interdiction and prejudice. . .

Accumulation of knowledge and the development of intellectual power are essential elements in any education that fits a student to solve the problems he will encounter. But a sense of values and a soundness of judgment must be combined with technical competence in any field if the college graduate is to discharge his responsibilities effectively. . .

Any claim to liberal education involves a certain minimum competence in each of the three great areas: natural science, social science, and humanities. Even minimum competence means not only awareness of subject matter, but some facility in the appropriate methods of thought and a sense of values in each area. One weakness we sense in a too exclusive emphasis on physical science is the consequent cast of mind that rejects as unworthy any domain in which the methods of hard logic or quantitative analysis cannot be applied. The ability to collect quantitative data, to evaluate such data, to recognize interrelations among them, all this is clearly an essential product of the education of engineers or scientists. But even more important is the ability to make wise decisions when the available data are not and cannot be expressed in quantitative terms. The vast majority of decisions made by every individual must be made in the absence of satisfactory quantitative data.

Education in science and engineering can provide certain attributes useful throughout life, namely, the ability to use elementary logic, the critical faculty including the faculty of self-criticism, the spirit of free inquiry, personal integrity, and professional responsibility. It is weakest in the development of human and social values, and in these it needs to be supplemented through education in the humanities and social sciences. In itself, however, education in science and engineering need not be narrower than education in literature. Education in any field can be broad or narrow depending upon content and method. Narrow education is concerned primarily with special knowledge and techniques; broad education, whether general or professional, is concerned with intellectual power and wisdom. From Report of the Committee on General Education, M.I.T.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Atomic-Energy Report

THE six months, January through June, 1950, were a time of diversified activity in the national atomic-energy project, according to the Eighth Semiannual Report of the Atomic Energy Commission, July, 1950. The rate of current operations accelerated, and at the same time major decisions were taken on the future course of development, the report indicates.

Fissionable material production proceeded at the lowest unit cost and highest output on record.

Work on experimental reactors of designs considerably in advance of any now in operation reached the development and construction stage. The two reactors under construction are research units; two others in the design stage are primarily designed to advance the naval application program.

Research work in basic nuclear phenomena, in biological and medical fields, and in radiation effects was expanded with the completion of new laboratories and equipment and the strengthening of the technical staffs of the operating contractors.

Construction proceeded on schedule both under the plant expansion program undertaken in late 1949 and under programs previously authorized. Work continued on long-range research and development and on improved types of production facilities.

Development of design for the intermediate power-breeder reactor at Knolls was deferred and many of the engineers and scientists at the Knolls Atomic Power Laboratory were reassigned. Much of the knowledge gained in studies on this project will be brought to bear on the problems of an intermediate submarine reactor, the second machine for submarine propulsion in the current program. The Commission feels that this concentration of effort on propulsion reactors will at the same time advance progress toward stationary power reactors.

On January 31 the President announced that he had directed the Commission "to continue its work on all forms of weapons, including the so-called hydrogen or superbomb." In this connection adjustments were made in various phases of the program, requiring a substantial expansion of facilities and work projects. These actions have been taken in close coordination with the Department of Defense. The first estimates of cost for these facilities are contained in a supplemental appropriation request for 260 million dollars which the President sent to the Congress on July 7.

During these six months, several changes occurred in the membership of the Atomic Energy Commission. Two original members, David E. Lilienthal, the first chairman, and Lewis L. Strauss, resigned to return to private life. In May, Thomas E. Murray became a member of the Commission.

Continuing the pattern of previous midyear reports to the Congress, this Eighth Semiannual Report of the Atomic Energy Commission reviews in some detail one major phase of the national atomic-energy program. The chief subject reported is control of radiation hazards. The report is designed not only to inform the public generally but to make available information useful in civil-defense activities.

The radiation safety record of the eight years of atomic-energy operations is cause for pride. Under the Manhattan Engineer District through 1942–1946, eight overexposures and two fatalities occurred from radiation accidents; since Jan. 1, 1947, there have been no deaths but five injuries from radiation. Protection of the environment has been an important consideration in all atomic-energy research and operational activities. Radioactive materials and wastes have been closely controlled to prevent radiation damage to property and people inside and outside the program. The Commission believes that the heavy expenditures devoted to radiation-protection measures and to research in this field have been soundly invested.

Atomic Research Reactor

THE nation's largest and most powerful research reactor began operating recently at the Brookhaven National Laboratory, nuclear research center supported by the Atomic Energy Commission at Upton, N. Y.

At 2:30 a.m. on August 22, Dr. Lyle B. Borst, in charge of the reactor (atomic pile), signaled for removal of control rods, thereby starting the initial chain reaction. Loading of uranium to bring the reactor to its full designed power will continue

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

for several months. Meanwhile, scientific experiments will begin, with the reactor operating 24 hr a day.

The "atomic furnace" is an air-cooled, graphite-uranium pile which, at its designed power level, will develop heat at a rate of 30,000 kw, several times that of the AEC reactor at Oak Ridge National Laboratory (Tenn.).

Brookhaven's reactor itself is a giant cube of graphite into which uranium metal is inserted in a very exact pattern. Its primary purpose is to produce neutrons for scientific experimentation. Neutrons are the particles of the nucleus of an atom which most easily split other nuclei. In a reactor this splitting becomes a chain reaction, in which neutrons cause uranium nuclei to fission (split), thereby releasing more neutrons which split more uranium nuclei, producing more neutrons, and so on.

The dense population of neutrons inside the reactor gives ample opportunity to gain further knowledge of the neutrons themselves and of substances exposed to them. The neutrons will be utilized by inserting materials into the reactor, or by allowing beams of neutrons to emerge under controlled conditions through holes in the shield surrounding the reactor.

Most chemical elements, when inserted in the reactor and bombarded by neutrons, emerge radioactive. Known as radioisotopes, they are used by physicists and chemists to study the fundamental nature of matter. Many radioisotopes decay by emission of rays or particles in short times (minutes, seconds, or less) and thus require study close to the reactor. For this reason, Brookhaven's reactor has pneumatic tubes which whisk samples to be studied into the reactor and out to adjacent laboratories in a few seconds. Other radioisotopes which exist for longer periods will also be studied.

Other types of experiments make use of the neutrons within the pile, or beams of neutrons emerging through openings in the shield wall. Metallurgists interested in the design of future reactors which can be used for submarine power plants, plutonium production, or commercial power, will study the changes in structural properties of materials when exposed to the neutrons and other rays inside the reactor. Biologists study the changes in plants and animals when exposed to the radiations from the reactor. The neutron beams emerging from the reactor will be most useful in getting more information about the neutron itself and the ways in which it interacts with nuclei and atoms.

The layout of the reactor and its equipment are especially designed to accommodate a larger number of simultaneous neutron-using experiments than are possible with any other known reactor.

Radiation Counter

A NEW instrument for the detection and counting of alpha, beta, and gamma particles has been announced by General Electric's Special Products Division.

Called a "universal scintillation counter," the device provides low background alpha counting and high-efficiency beta and gamma counting, according to engineers of the company's General Engineering and Consulting Laboratory who worked on its development. It is intended for use in counting samples and smears in health physics work, for analytical determination of disintegration rate, and in counting radiation of ore samples. The sampling chamber can accommodate specimens up to 2 in. in diam.

When the instrument is used as an alpha counter, the background is not more than a few counts per hour, G-E engineers said. Other features include short resolving time, 45 per cent counting geometry, and no microphonics. Counting efficiency is essentially 100 per cent for thin samples.

As a beta counter, the device offers several advantages over an end window Geiger-Mueller counter, it was said. These are: higher counting geometry, no filtration, higher-speed counting, and less change of characteristics with time.

As a gamma counter employing a liquid phosphor, it has a sensitivity many times that of an ordinary Geiger-Mueller counter.

Designed for use with a standard scaler supplying high voltage, the scintillation counter employs a 5819 photomultiplier tube. In operation, a sample is placed in the slide chamber of the unit. When the sample is put in the counting position (slide in), particles strike a phosphor causing scintillation which is detected by the photomultiplier tube.

Radioactive Wastes

HOW extremely pure distilled water is extracted from dangerous radioactive wastes was revealed recently in Chicago, Ill., at a meeting of the American Chemical Society, by Dr. George E. McCullough of the Knolls Atomic Power Laboratory, operated near Schenectady, N. Y., by the General Electric Company for the Atomic Energy Commission.

Dr. McCullough addressed a symposium on disposal of radioactive wastes, a vital problem confronting atomic-energy installations. Such wastes may give off dangerous radiation for years and their disposal, therefore, requires special precautions.

The KAPL disposal unit, recently placed in full operation, is believed to be the most complete and systematic plant of its kind thus far built, according to Dr. McCullough. It is capable of handling more than 2,250,000 gal of waste per year, on a three-shift basis, operating full time. At present, however, it is being used on only two shifts, treating 125,000 gal per month, at an over-all cost of about 14 cents per gal. Full-time operation would reduce this to about $11\frac{1}{2}$ cents.

The Mohawk River, on which the Knolls Laboratory is located, provides a convenient place to discharge wastes, but a fundamental restriction was that nothing with detectable amounts of radioactivity be dumped in the river.

Wastes from all parts of the laboratory are collected in stainless-steel tanks, each of 10,000 gal capacity. After a tank becomes full, and a sample is tested, the contents are fed into an evaporator which is really a huge still, operating in a partial vacuum. The water comes off as vapor, which is then condensed and collected in one of two 5000-gal tanks. Again, a sample is tested. If the radioactivity is sufficiently low, it is discharged into the storm sewer and thence to the river. If not, it is passed through the evaporator and distilled again. Such water is really pure enough to use in the laboratory laundry, and for various other purposes, though this is not being done at present.

The material which was dissolved or suspended in the waste liquid is concentrated at the bottom of the evaporator as a thick "slurry" or mud. It is still sufficiently fluid to be pumped through pipes to a vacuum drier where it is spread on a large heated stainless-steel rotating drum. As it turns, the remaining water evaporates and the dried waste is scraped off to fall through a chute into a room below which is shielded with concrete walls. By means of remote controls, operated in another room, stainless-steel cans are lifted into place to collect the solid wastes.

At present, Dr. McCullough explained, the drums of solid radioactive material are being stored. They contain such a conglomerate mixture of chemicals that it is not practicable to

attempt any separation of useful radioactive elements. Their ultimate disposition has not yet been decided, though one possibility is that they will be embedded in concrete blocks, carried out to sea, and dumped.

Vibratory Ball Mill

A VIBRATORY ball mill recently developed at the National Bureau of Standards rapidly and completely grinds cotton into particles a few microns in length with little or no oxidative change or contamination of the cellulose. Grinding takes place as 3700 steel balls, colliding over 100,000 times per sec, pulverize the material caught between them. As the new mill produces a more uniform powder and is more efficient and easier to operate than previous devices of this kind, it is expected to find extensive application in the grinding and blending of a variety of substances such as pigments, ceramic materials, metal powders, resins, and plant and animal tissues.

The mill was constructed at the Bureau in connection with a program sponsored by the U. S. Department of Agriculture on the chemical deterioration of cotton during processing and use. To learn more about the chemical changes which occur when cotton deteriorates, the Bureau undertook to apply the techniques of infrared spectrophotometry to cotton cellulose. As the spectra obtained from fibers laid side by side were not satisfactory, it was decided to reduce the fibers to a powder and measure the spectral absorption of the powder in a mat or in suspension in a suitable liquid. Several well-known methods for grinding materials were therefore tried, such as an ultrasonic generator and a Wiley mill in which the material is cut between fixed and moving blades. However, the products thus obtained contained much coarser matter. In an effort to provide a method which would reduce the entire sample to a finely divided state without contamination and with a minimum of chemical change, the vibratory ball mill was developed.

In the Bureau's mill a cylindrical jar, suspended by leaf springs and containing steel balls in contact with the material to be ground, is swung through a circular path. This excites the steel balls, causing the numerous collisions that grind the material in the jar. At the same time the jar rotates slowly about its axis. In this way the material being ground is prevented from settling to the bottom of the jar, and uniform grinding is obtained.

Motion of the jar is produced by means of a horizontal shaft connected at one end, through a flexible coupling, to a 0.25-hp motor, and at the other end to an eccentric weight. The weight, rotating at a speed of 1800 rpm, drives the weight housing in a circular path that is confined within certain limits by the flexural resistance of the springs. The jar containing the sample is held in a cylindrical holder, which is attached to the weight housing by means of a greased slip ring. A small difference in diameter between the flange of the jar holder and the slip-ring groove permits the holder with the clamped-in jar to be rolled around the groove circumference by centrifugal force. This rolling or rotation of the holder and jar, which takes place at a rate of about 4 rpm in a direction opposite to that of the rotating weight, continually redistributes the material being ground.

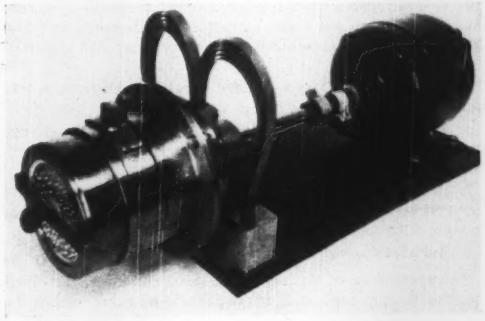

FIG. 1 ASSEMBLED VIEW OF VIBRATORY BALL MILL

In experiments at the National Bureau of Standards, the mill reduced 5 grams of cotton in 30 min to particles 10 microns or less in major dimension. X-ray diffraction measurements showed that the cellulose was converted almost completely to the amorphous form in this time. Except for the decrease in the degree of polymerization which resulted from the cutting of the cellulose chains, there was no degradation of the cotton. Nor was the ash content of the cotton perceptibly increased by the grinding process.

Oceanography

WHILE much is known about the land areas of the earth and their natural resources, most of the details of the seas, which cover three times as much area, are still little known, it is pointed out in the September, 1950, *Industrial Bulletin* of Arthur D. Little, Inc. In a hungry world, the food resources of the sea must be fully utilized, and in a world geared to rapid transportation and communication, the effect of the sea on weather, radio reception, and shipping must be fully understood.

Since oceanography deals with both the interrelation between marine organisms and their environment and between the ocean and its boundaries, many sciences and fields for research contribute to the slowly building body of knowledge. Oceanographers are usually trained in physics, chemistry, biology, or geology, and adapt the methods of each science to the parts of the problem. Much of the research is done in teams, for many sciences are needed to explain some of the ocean's complex phenomena. Students in oceanography usually supplement college courses with summer work at an oceanographic center. Several government agencies, universities, and private institutions carry on oceanographic research, and many universities offer some related work in connection with other courses, such as marine biology.

The sediment of the ocean bottom reveals much information on the history of the earth. New "coring" devices developed during and since the war can take samples up to 60 ft deep from the material covering the ocean floor. Since it probably takes 500 to 3000 years to deposit an inch of sediment in the deep ocean, the fossil remains in such a sample can give evidence of climatic changes occurring over the past million years or more. The deposition of marine sediments is of increasing interest to petroleum geologists in the search for new oil fields on the continental shelves.

Continuously recording echo-sounders, which "bounce" sound waves off the bottom, combined with use of the Loran radio network to fix the ship's position, help in charting the bottom accurately. It may also be possible for submarines with such charts to ascertain their positions by the use of recording echo-sounding devices. From the bottom profiles much has been learned of the gigantic mountains, canyons, and plains of the ocean floor. Both geological information and better navigational charts will result from such studies.

The problems of circulation of the water are fundamental to

oceanography. Wind, climate, and the character of the ocean bottom influence ocean currents. Greater knowledge of the interaction of the ocean surface and the layer of air above it would help in advancing long-range weather forecasting. On a more local scale, recent studies of circulation in tidal waters have been invaluable to coastal communities and industries seeking to utilize the ocean for waste disposal.

Using Loran and the bathythermograph—an instrument for measuring and recording the temperature of the water from the surface down to 900 ft, from a vessel moving at full speed—a current can be followed. On recent cruises of the Woods Hole, Miss., Oceanographic Institution's research ship, *Atlantis*, it was found that the Gulf Stream meanders in wide loops from its "mean" course as noted on the charts. Since unsuspected and constantly shifting eddies and countercurrents could influence considerably the course of a ship, an iceberg, or a storm, such studies are of immediate practical interest.

A new current-measuring device developed at Woods Hole may prove to be a valuable aid to navigation, although it was originally developed for charting currents. It uses the earth's magnetic field as a reference frame, and hence does not require celestial, terrestrial, or electronic landmarks, which are frequently unavailable. Since ocean currents are sometimes as swift as five knots, and many ships can make only ten knots or so, it is important to economy of operation as well as to navigational accuracy to know whether the featureless wilderness of water is moving with, against, or across the ship's path.

Data accumulated over a number of years, and thought to be mainly of academic interest, led to many practical applications during the war. Extensive studies of wave formation, frequency, and height aided in planning amphibious landings and cargo movements. These studies are continuing; such information is useful also for naval architects and for engineers planning wharves, breakwaters, oil-well platforms, and underwater structures, as well as in preventing beach erosion.

Fly-Ash Emission Tests

TESTING for fly-ash emission by smaller steam plants need not be too time-consuming nor require elaborate and expensive equipment, according to Philip F. Best, chief mechanical engineer of the Thermix Corporation, Greenwich, Conn. Mr. Best presented his paper, an ASME Fuels Division contribution, before a meeting of the Smoke Prevention Association of America, held in Montreal, Quebec, Canada

He pointed out that the prime purpose of such tests is to establish the amount of fly ash being discharged per cubic foot of flue gas. However, secondary benefits derived often pay sufficient returns to defray the cost of the test and the equipment required for the testing. For instance, knowledge of the combustible content of the ash can often lead to fuel-saving adjustment of the stoker or combustion controls. Furthermore, if dust-code violation is indicated, the information gained as to the amount and the size of the fly ash collected in the test can be very helpful in the proper selection of fly-ash collecting equipment.

According to Mr. Best, the requirements of a good authentic fly-ash emission test are as follows:

1 A good location must be chosen. Sampling stations should be kept away from fan inlets and outlets, particularly outlets. Also bends, elbows, or dampers should be avoided.

2 The velocity in the nozzle which samples the gas in the duct must be substantially the same as in the duct, otherwise fine particles which follow the gas stream will be rejected if the velocity in the nozzle is too low, and too many will be admitted if the velocity in the nozzle is too high.

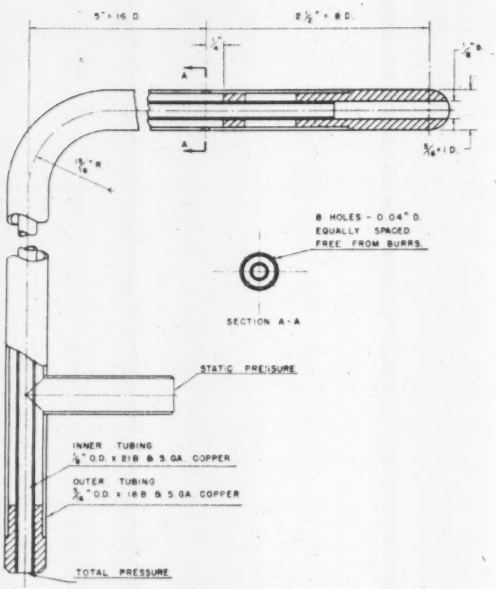

FIG. 2 CONSTRUCTION DETAILS OF STANDARD PITOT TUBE FOR USE IN FLY-ASH TESTING EQUIPMENT

3 A filtering medium must be provided to remove the sampled dust from the gas with good efficiency, so that the fine particles are not allowed to escape.

4 A summary of the results must be made, leading to a definite conclusion of size and amount of dust entrained in the flue gas.

The following main equipment required for an adequate test can be made either by the maintenance department of the plant running the test, or can be purchased with little expense:

1 A Pitot tube, Fig. 2, to measure the velocity in the duct.

2 An inclined-type manometer to convert the velocity head to inches water gage.

3 A sampling nozzle, shown in Fig. 3, which is usually 1-in. tubing with the end which projects into the gas stream being feathered to disturb the gas flow as little as possible.

4 A filter bag, to go over the end of the sampling nozzle. Since the filter bag is under suction, it is necessary to apply either a glass or metal housing over the filter bag also shown in Fig. 3.

5 A pipe with measuring orifice installed with provision to measure temperature as in Fig. 3.

6 An air or steam ejector to pull the gas through the sampling device. This is installed after the orifice in Fig. 3. An example of its construction is shown in Fig. 4.

7 A thermometer for measuring duct temperature and temperature at the orifice, and also a U gage for measuring the pressure differential around the orifice.

8 Sufficient hose to connect the various parts.

An expenditure of no more than $100 should be involved for purchasing and making the various parts, including labor.

After this equipment has been assembled and connected to-

gether, there should be no difficulty if the following procedure is followed:

1 Select the best possible point at which to install the sampling station. Estimate the total number of points to sample. If the conditions are good for the test—that is, if there is considerable straight duct before and after the sampling point—then there need not be many sampling points required. However, if it is impossible to find a theoretically good sampling station, then more sampling points will be required because of possible dust stratification in the duct.

2 Calculate the volume of gas necessary to produce the required velocity in the nozzle to duplicate the velocity in the duct at the particular point being considered.

3 Since there will be a temperature drop between the duct and the measuring orifice, depending upon the length of connecting hose and also the ambient temperature at which the test is being made, some estimate must be made of what the temperature at the orifice will be during the test. With this information, a figure called "Equivalent CFM" can be obtained.

$$\text{Equiv cfm at orifice} = \frac{\text{cfm in duct} \times \text{est abs temp of orifice}}{\text{abs temp of duct}} \times \sqrt{\frac{\text{abs temp of orifice when calibrated}}{\text{est abs temp of orifice}}}$$

4 From the calibration curve of the orifice the proper resistance to be used across the orifice for this equivalent cfm is obtained.

5 With the apparatus properly assembled, the sampling nozzle is pointed into the flow of gas at the first sampling point, and the resistance across the orifice is adjusted by the use of a valve between the orifice and the ejector. In most cases no more than a five-minute run will be necessary for each point being sampled. The temperature of each point during this run should be kept with a thermometer installed as shown in Fig. 3.

6 Inasmuch as it is impossible to estimate the correct temperature drop between the duct and the orifice, it is necessary to correct for this. This is done in a manner similar to Step 3, except that it will be the reverse process and the following formula will apply:

$$\text{Cfm sampled in duct} = \frac{\text{cfm passing orifice} \times \text{abs temp of duct}}{\text{actual abs temp of orifice}} \times \sqrt{\frac{\text{actual abs temp of orifice}}{\text{abs temp of orifice when calibrated}}}$$

7 To obtain the total cubic feet sampled, each corrected cfm should be multiplied by the number of minutes sampled at that particular point and the results added.

8 In order to obtain the dust loading of the gas, it is necessary to weigh the dust caught. Inasmuch as there will be a difference in the moisture content of the filter bag before and after the test, the filter bag should be dried and weighed before installation in the housing, and the bag, together with the dust caught, should be dried and weighed after the test. The difference will represent the actual weight of the dust caught. The dust loading in grains per cu ft is obtained as follows:

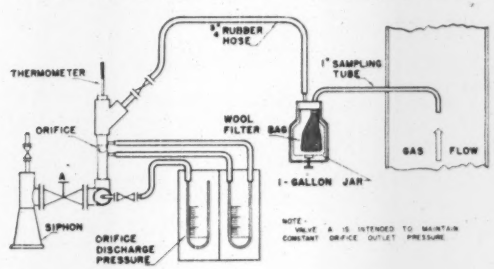

FIG. 3 TYPICAL TEST SETUP OF FLY-ASH TESTING EQUIPMENT

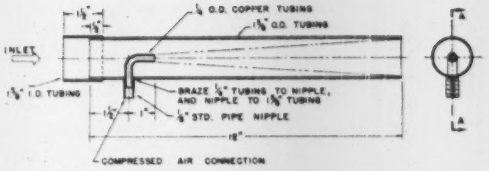
¼ O.D. COPPER TUBING
1⅜" O.D. TUBING
INLET
⅛" I.D. TUBING
BRAZE ¼" TUBING TO NIPPLE, AND NIPPLE TO 1⅜" TUBING
⅛" STD. PIPE NIPPLE
COMPRESSED AIR CONNECTION

FIG. 4 CONSTRUCTION DETAILS OF EJECTOR USED IN FLY-ASH TESTING SETUP

Dust loading in grains per cu ft = lb dust caught × 7000 total cu ft sampled

With the determination of the dust loading in grains per cu ft of flue gas, it can be determined directly whether or not fly ash is being emitted in excess of code requirements.

The dust which has been caught during the test can be used to determine other information if desired. This dust can be analyzed for combustion content, and also, if the amount of dust being emitted is in excess of the code requirements, a size analysis should be made of the dust to determine what corrective means should be used.

Mr. Best pointed out that the foregoing procedure is not an attempt to duplicate the procedure as outlined in the ASME Power Test Code, and certainly many additional precautions and provisions must be observed when testing a dust collector, for instance, than have been outlined. Any testing made to prove a guarantee, or when the test must be certified, should be made in strict compliance with the ASME Power Test Code procedure.

Coal Preparation

A NEW process for the combined cleaning and dewatering of fine sizes of coal has been brought closer to commercial application as the result of experiments undertaken by the Bureau of Mines in co-operation with private industry, according to a recent report.

In 1947 joint research by the Bureau and private industry produced a kerosene-flotation process capable of cleaning and dewatering smaller sizes of coal in a combined operation. During these preliminary studies the method was employed successfully on sludge, or the underflow of dewatering screens and on raw-coal fines.

To test the practicability of the process on a commercial scale, the Sloss-Sheffield Steel and Iron Company of Birmingham, Ala., constructed two plants at its Bessie and Kimberly mines to treat sludges and fines screened out of run-of-mine coal. Both plants are demonstrating that the process compares favorably with more conventional methods, according to the report. The treatment of raw-coal fines under the new method virtually eliminates the sludge and slurry problems "which in the past have been inseparably associated with wet methods of coal preparation."

Other major advantages of the process, the report points out,

are that it greatly reduces the need for settling tanks in wet preparation plants handling raw-coal fines, and that it permits greater recovery of coking-grade coal products which might otherwise be lost.

Detailed descriptions of the operating procedures employed at both plants are given in the publication. It also includes full-page photographs of installations at the Bessie and Kimberly mines, a Kimberly flow sheet, and charts illustrating various phases of the process.

A free copy of Report of Investigations 4707, "Recent Developments in Combination Cleaning and Dewatering of Fine Sizes of Coal," by B. W. Gandrud, supervising engineer of the Coal-Preparation Section of the Bureau's Southern Experiment Station, and H. L. Riley, assistant coal-preparation engineer of the same station, may be obtained by writing to the Publications Distribution Section of the Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Lignite Gas

MORE than 8,220,000 cu ft of potential industrial gas, which may mean a new era of prosperity for the Great Plains States, were recently produced from lignite during the 15th experimental run in the Federal Bureau of Mines pilot plant on the University of North Dakota campus at Grand Forks, N. D.

Lignite—a low-grade coal with a high moisture content—produces a water gas, often called blue gas because of its blue flame, and is composed chiefly of hydrogen and carbon monoxide.

This gas may provide a way for greater use of the nation's abundant lignite reserves, the great bulk of which is in North Dakota, Montana, and South Dakota, Dr. Alex C. Burr, chief of the Bureau's Fuels Technology Division at Grand Forks, stated.

Hydrogen in the gas could be used in producing synthetic liquid fuels, reducing Minnesota iron ore, manufacturing ammonia for fertilizer for agricultural use, and for the hydrogenation of vegetable oils and fats, Dr. Burr pointed out.

About 185 tons of lignite were gasified in the pilot plant during the 15th test run—longest to date. About 45,000 cu ft of gas was produced from each ton. Begun early in August, the test ran continuously for 802 hr and gasified 462 lb of lignite per hr.

Eventual commercialization of the gasification process will not only provide a versatile industrial raw material for the Great Plains and nearby states, but also will increase lignite production, Dr. Burr said.

By adding catalysts such as cobalt and iron, synthetic liquid fuels could be produced from the gas and a good grade of sulphur-free car oil obtained. This gas also could be used in place of natural gas for heating purposes.

High temperatures ranging from 1600 to 1924 F were maintained continuously during the month-long run, subjecting the gas-generating equipment to severe strain. Temperature effect on gas production—the main purpose of the run—was studied.

During gasification, lignite was fed into the top of an 18-ft-long circular retort made of chromium-nickel alloy. Heat was applied to the retort, steam introduced with lignite, and water gas produced. Char residue was removed at the bottom of the retort, and gas was piped into a holder at the rear of the pilot plant.

The Bureau of Mines pilot plant at Grand Forks first began operating in 1945. During 15 runs, more than 65 million cu ft of gas was produced.

British Aircraft Display

THE question in the minds of the technical experts at the Society of British Aircraft Constructors Flying Display and Exhibition at Farnborough, England, September 6 to 10, was whether the promises of the 1949 planes had been proved in the planes of 1950, according to a report by Charles Gardner, received from the British Information Services.

Taking civil aircraft first, there was little doubt about the answer, writes Mr. Gardner. The Comet jet liner came to Farnborough in 1950 with an unprecedented year of trouble-free record breaking behind it. At Hatfield there is a busy production line as final proof of the faith in this airplane. Heads can no longer be shaken at the Comet, nor at the jet-propeller Viscount, which has flown 36 successive routine passenger-carrying service flights to Paris. There could be no more convincing trial of a new airplane, and no more convincing faith than British European Airways in putting a prototype on to a fare-paying scheduled service in this way.

Last year, with the Comet and the Viscount, the Apollo, and the Marathon II, Britain announced that she had put her trust in gas-turbine engines for civil transport.

This year at Farnborough she has proved her case.

On the military side all the emphasis was also, as it must be, on jet planes, Mr. Gardner reports. As an earnest indication of things to come, there is the Sapphire Meteor—a standard Meteor VIII fitted with two huge new Sapphire jet engines, each one as powerful as all four engines of a Superfortress. This Sapphire Meteor, an experimental, is easily the most powerful

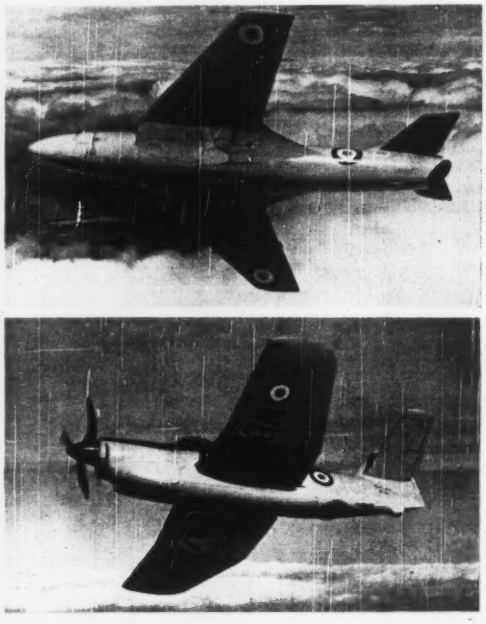

FIG. 5 BRITISH MILITARY AND NAVAL AIRCRAFT ON DISPLAY AT FARNBOROUGH SHOW

[*Top:* Hawker P1081, new sweptback-wing jet fighter with "straight-through" jet pipe. It has a Rolls Royce Nene engine. *Bottom:* Blackburn Y.A.5, submarine killer of the British Navy. It has a retractable radome (radar scanner) and folding wings.]

single-seat fighter ever built, and it has a rate of climb that can only be rivaled by a rocket, he states.

Another important variant of the Meteor was the ground-attack model, which is fitted to take 16 rockets of 95 lb or four 1000-lb bombs. This plane was rushed through as a result of the early lessons of Korea. To overcome take-off difficulties on small tropical strips, rocket assistance gear is also fitted, along with ventral and wing-tip tanks, to give added range. As a tank buster and tactical support plane, this special Meteor, easily adapted from the standard machine, plugs a gap in allied armament.

As for pure fighters, Mr. Gardner mentions two new high-performance machines which are believed to be as fast as anything else flying, and also maneuverable at a great height. They are the Hawker 1081 and the Vickers 535. In these two airplanes Farnborough visitors saw perfect examples of how a vital warplane is steadily developed until it is just right for its job. Originally (which is now some three years ago) Hawkers and Vickers designed experimental jet planes which had straight wings, were very fast, and were at that time highly regarded. They were the Attacker and the Sea Hawk. A year later, however, both these planes had blossomed out into sweptback wings, were flown past Farnborough crowds at 650 mph, and were still officially "experimental." A version of the Attacker and of the Sea Hawk was then "consolidated" for the Royal Navy, but for the land-based fighters the development work still went on. This year the 1081 and the 535 now labeled "fighters" were exhibited.

Another new and important plane which has grown naturally from its predecessors is the two-seat radar-carrying night fighter Venom, which is reputedly capable of tackling any enemy up to 50,000 ft. A descendant of the Vampire and of the day fighter Venom, this plane can be a considerable addition to the allied stock of all-weather fighters which are becoming more and more vital now that clouds and bad weather are no longer the hindrances to the bomber that they were in the 1940's.

There were still other prototypes and even more "consolidation" of previous machines at Farnborough, according to Mr. Gardner. There were the Heron feeder liner and two new naval antisubmarine planes, while in the big exhibition tent there was a heartening range of new engines for planes which are as yet still secret.

There was one special exhibit which in the long run may prove even more important than any of these, Mr. Gardner points out. It was the new rocket motor, the Beta. This hydrogen-peroxide engine is Britain's first full-sized rocket designed to power an airplane.

British Jet Engine

DETAILS of the Armstrong Siddeley Sapphire, claimed to be the newest and most powerful jet engine in the world now flying, have recently been disclosed.

Developed by the Hawker Siddeley Group at Armstrong Siddeley Motors, Coventry, England, it is officially stated that the new giant turbojet has successfully run the 150-hr service-type test at 7200 lb thrust. This is 1000 lb more than any previously announced type-test figure for any engine.

Coincident with the release of the Sapphire is the news that it is already flying, with two engines having been installed experimentally in a Gloster Meteor 8, interceptor fighter of the RAF and Western Union air forces.

Technically the Sapphire is a straight jet engine with a sea-level static thrust of 7200 lb for a specific fuel consumption of 0.907 lb per hr per lb thrust. It has an axial-flow compressor and an annular combustion chamber. Its net dry weight is 2500 lb. Details of the Sapphire Meteor performance are still secret.

Dimensions of the engine are as follows: Diameter over bare engine, 32.25 in.; diameter over trunnion mounting, 37.3 in.; over-all length from front of nose fairing to exhaust-cone rear flange, 133.85 in.; jet pipe diameter over heat shroud, 24.5 in.; frontal area, 6.8 sq ft; and thrust per sq ft of frontal area, 1100 lb.

Turboprop Engine Performance

AN analysis was made recently of the performance of basic, reheat, regenerative, and regenerative-plus-reheat turbine-propeller engines, the results of which are reported in NACA Technical Note 2155 by Tibor F. Nagey and Cecil G. Martin of the Lewis Flight Propulsion Laboratory, Cleveland, Ohio. The analysis covered an over-all range of flight speeds from 200 to 500 mph, altitudes from 0 to 50,000 ft, and turbine-inlet temperatures from 2000 to 3000 R for a range of compressor pressure ratios from 6 to 42. The authors compared the effects of flight and engine conditions on fuel consumption, power per square foot of engine frontal area, power per pound of engine weight, and airplane range for the various engines.

The basic turbine-propeller engine consists of inlet diffuser, compressor, combustor, turbine, and exhaust nozzle.

The operating cycle of the reheat engine is essentially the same as for the basic engine, except that expansion occurs in two turbines with additional fuel being burned between the turbines to increase the total turbine work.

The regenerative engine deviates from the basic engine by having the exhaust gases from the turbine directed through a regenerator that heats that air leaving the compressor previous to the addition of fuel in the combustion chamber, which reduces the amount of fuel required to attain the desired turbine-inlet temperature.

The regenerative-plus-reheat turbine-propeller engine combines the features of the foregoing engines.

According to the results, comparison of the minimum specific fuel consumption of the regenerative-plus-reheat turbine-propeller engine with the simpler turbine-propeller engines showed that at sea level the combination of regeneration and reheat gave a decrease in minimum specific fuel consumption of approximately 2 per cent from that of the reheat engine, 6 per cent from that of the regenerative engine, and 10 per cent from that of the basic engine. At an altitude of 30,000 ft, the corresponding decreases in fuel consumption were 4, 5, and 7 per cent, respectively. The compressor pressure ratios for minimum specific fuel consumption for the regenerative-plus-reheat engine, which were 8 at sea level and 12 at an altitude of 30,000 ft, were lower than those for both the reheat and basic engines and slightly higher than for the regenerative engine at both altitudes.

The range of the turbine-propeller engine increased at a decreasing rate as the turbine-inlet temperature was increased (no increase in engine weight was assumed to accommodate increases in turbine-inlet temperatures). For the basic turbine-propellet engine at a flight speed of 500 mph and an altitude of 30,000 ft, increasing the turbine-inlet temperature from 2000 to 2500 R increased the maximum range about 19 per cent, whereas an increase from 2000 to 2500 R indicated a 32 per cent increase in range. These increases in range, however, were accompanied by increases in compressor pressure ratio.

A turboprop engine with 100 per cent reheat between turbines, and with a work distribution between turbines that gave approximately maximum range, resulted in at best about 10 per cent improvement in airplane range at low flight speeds and

about 15 to 20 per cent greater range at a flight speed of 500 mph than the basic engine. This trend was constant as altitude was changed. The performance calculations did not include the additional weights required for reheat equipment and controls, and the turbine efficiencies assumed were probably optimistic for this engine when compared with the basic engine.

The engine with regeneration, operating with a regenerative effectiveness of 0.5 gave about 3 per cent greater range than did the basic engine at all flight speeds and altitudes.

The engine operating with a combination of regeneration and reheat indicated a slightly greater improvement in range over that of the basic turboprop engine at all flight speeds and altitudes than that found for the reheat engine.

Rearward-Facing Seats

A REARWARD-FACING seat for use in military transport planes is being delivered to the U. S. Air Forces, it is reported in the Cado *Technical Data Digest*, September, 1950.

Revolutionary in function and design in that it faces backward and can withstand a force of 8000 lb, the new seat is being installed in C-54 transports and other aircraft. Twenty C-54's operated by the Military Air Transport Service will be equipped with the first 300 seats to be produced by the Beech Aircraft Corporation.

Designed to requirements furnished by engineers of the Aircraft Laboratory and the Aero Medical Laboratory, Air Materiel Command Headquarters, the new development represents the result of an extensive research for a high-strength passenger seat which will provide its occupant with an extra safety factor during a crash landing or ditching. Although more than three times as strong as the old type, the new seat is actually lighter, weighing only 50 lb per double seat compared to 65 lb for the old model. The high-strength seat can withstand a load of 16 g, whereas the old seat was designed to take a load of 6g based on two 170-lb occupants. A load of 16g corresponds to a pressure of 8000 lb for two 250-lb occupants.

The basic structure of the new seat is made of aluminum sheet, replacing the heavier steel tubing previously used. The use of foam rubber in the arm rests, bottom, and back cushions not only makes it more comfortable, but also results in a saving in weight. AMC engineers have selected a woven vinylidene chloride fabric as covering in place of wool fabric. This is the same material that is used in automobile "plastic" seat covers. It has several advantages over wool in that it wears longer, is washable, mothproof, fungusproof, waterproof, and fire-resistant.

In future aircraft, as in the C-54's, the Air Force is planning to face passenger seats toward the rear of the plane. AMC's human decelerator (see MECHANICAL ENGINEERING April, 1950, page 333), a device which measures the decelerative forces on the human body during crash landings, has shown that human subjects can easily withstand a force of 35g when seated in a backward-facing position. Moreover, a survey conducted by MATS in 1947 to determine the attitude of passengers toward rearward-facing seats showed that more than 90 per cent did not object to the idea. Tests have also shown that the back of a seat is much more effective than a shoulder harness in preventing injury during rapid deceleration.

Another practical feature of the new seat is that it can be folded and stored upright along the wall of the plane. This enables ground crews to convert a plane from passenger to cargo use in a matter of minutes. No special tools are needed to fold the seats.

A de luxe passenger version of the aft-facing seat has been developed for use in planes carrying VIP's (Very Important Persons). This seat is practically the same as the standard version, except that it is stationary, has more upholstery, and includes a built-in parachute. The harness of the chute is tucked into a special fold on each side of the back cushion, so that the passenger can don the chute at a minute's notice. This seat, without the parachute, weighs only 60 lb per double seat, which is still 5 lb lighter than the old model. With two parachutes, the unit weighs 135 lb.

To date the Air Force has ordered 660 standard 15-g seats. Addjtional seats will be ordered for installation in all aircraft except fighters and trainers. These two types will use a 32-g seat now in the design stage. Naturally, the pilot's seat in all aircraft must face forward, in which case shoulder harnesses will still be used for protection against quick deceleration.

Air Force officials believe that the new seat will go a long way toward eliminating injury and death caused by seat failure during forced landings.

Lightweight Power Plants

ANNOUNCEMENT of air and hydrogen-peroxide high-speed turbine-driven accessory power plants for high-altitude supersonic missiles has been made by Marquardt Aircraft Company of Van Nuys, Calif., according to the September, 1950, Cado *Technical Data Digest*. These auxiliary power plants are less than one fourth the weight of conventional reciprocating-engine-driven power plants for the same horsepower and were developed by Marquardt to meet the hydraulic, electric, and fuel-pump requirements of ramjet and rocket-powered missiles and turbojet-powered aircraft.

Inasmuch as the ramjet and rocket engines have no turning parts, a turbine operating from ram air pressure is a logical choice as a prime mover for accessory power. The turbine in one application drives the various accessory units through a gear-reduction system. One design, however, eliminates the gear mechanism and is connected directly to a high-speed electric alternator. The units used with missiles govern the incoming air by means of throttle devices; for example, one model incorporates a bullet-shaped throttle in the nose of the unit. Those designed for jet-powered airplanes use air bled from the engine's compressor.

Marquardt is now in production and development on four different types of these accessory power plants. Future designs of this type of power plant for both missiles and piloted aircraft are based upon the production and development of air and hydrogen-peroxide-driven accessory drives for the following applications:

1 A Navy missile's complete accessory drive which consists of a high-speed ram air turbine driving two hydraulic pumps and a constant-speed alternator through a reduction gear. This unit uses a hydraulic speed control developed by Marquardt which maintains speed with 3 per cent.

2 A unit developed for an Air Force missile which drives a high-speed alternator direct. This unit utilizes a special electronic governor and throttle which maintains speed within $1^1/_2$ per cent.

3 A unit developed for missile application is a ram air high-speed turbine which drives direct a large-capacity fuel pump.

4 A complete accessory drive has been designed to operate from both hydrogen peroxide and ram air.

Turbine efficiencies higher than 83 per cent including gearbox losses have been achieved on test in a government laboratory.

Installations of these accessory power plants on standard turbojet-powered aircraft can be made at locations remote from the engine nacelle, and the air for the auxiliary unit is supplied

through a duct system. Because these units have only one quarter the weight of their respective standard counterparts, the potential weight saving in multiengine aircraft is obvious.

Turbosupercharger

A NEW turbosupercharger—the CH9—which is claimed to make possible compound-type engines that can outperform, economically, any large power plants flying today, has been announced by the Aircraft Gas Turbine Division of the General Electric Company.

Rigorously tested on the Pratt and Whitney R-4360-C engine, the new turbosupercharger utilizes a new power cycle that simplifies the engine, at the same time adding more power. It eliminates the conventional geared supercharger, or impeller, and permits operation without clutches, gearings, or fluid disks. There are no mechanical connections between engine and turbo.

The new turbo handles up to 350 lb of air per min, compressing it to a pressure of 50 in. Hg abs. With accessories, the unit weighs 300 lb.

According to a detailed study conducted by General Electric and Pratt and Whitney engineers, the R-4360-C with the new CH9 turbo can outperform, in every respect, the present R-4360 engine with its BH4 turbo.

Engineering results from the actual test-stand installation of the combined power plant show 32 per cent more power in take-off and 20 per cent lower fuel consumption.

Average true air speed can be increased substantially depending on flight distance, due to greater power, permitting flights at altitudes where turbulence and air drag are reduced. Despite increased speed and power, specific fuel consumption of 0.36 lb per bhp-hr can be realized. Cabin air conditioning can be provided by the CH9 at altitudes up to 30,000 ft.

The geared supercharger was eliminated through the development of a direct cylinder fuel-injection system on the R-4360 engine. As a result, the new turbo can provide full engine manifold pressure. An aftercooler makes a net reduction in cylinder intake temperature of more than 65 per cent, substantially increasing power and safety margins.

Better performance is further assured by the increased use of exhaust energy and simplicity of operation. Strategic materials have been reduced.

General Electric engineers pointed out that with the new power plant a large transport could fly from London to New York, eliminating all stops. On the other long flights, as from Paris to Dakar, or San Francisco to Honolulu, 10,000 lb or 75 per cent more pay load could be added.

Aluminum-Coated Steel

ONE of the promising technical developments of recent years is the progress made in the various methods of coating steel with aluminum, according to the Canadian publication, *Aluminium News*, for September, 1950. It has been established that aluminum-coated steel has high rust-resistant properties suitable for industrial and seacoast exposures, and in industrial and humid atmospheres it has been found superior to steel with galvanized coatings of similar thicknesses. The need for conserving many other metals now being used for coating, such as zinc, has given added value to successful efforts to coat steel with aluminum.

There are two types of aluminum coatings on steel. The first is a surface layer of aluminum-iron alloy which prevents scaling by oxidation at high temperatures. It is important that the compound should not form to such an extent that the surface becomes brittle and spalls. The second is a surface coating of aluminum to protect the steel from corrosion. There may or may not be an interfacial layer of aluminum-iron alloy which, if present, should be kept to a minimum.

Several methods may be used to coat steel with aluminum, and each produces its own type of coating with individual characteristics. Four processes are in present-day commercial operation: hot dipping, cladding by rolling, spraying, and calorizing. Three other processes have been developed but are not widely used: electroplating, chemical reaction, and casting (aluminum around steel, or vice versa, in the Alfin process).

Aluminum coatings formed on steel by hot-dipping vary from $^1/_2$ to approximately 3 mils (1 mil = 0.001 in.) in thickness, possess good continuity, and a relatively thin interfacial layer. From an operating viewpoint, this process appears to be the most economical. The Armco Steel Corporation is now using this method to produce "aluminized" steel sheet on a commercial basis. The process involves preheating the steel in a controlled atmosphere before it enters the aluminum bath. Other aluminum hot-dip processes are similar to hot-dip galvanizing, using a pickle followed by a molten flux, after which the steel enters the molten aluminum bath.

To permit bending and forming of coated products, the brittle nterfacial layer must be kept at minimum thickness. This can be accomplished by the addition of silicon to the aluminum-coating bath. Temperature is another important factor in the coating bath, as an increase in temperature tends to increase the thickness of the interfacial layer.

Aluminum may be sprayed on steel using either aluminum wire, the most widely practiced method, or aluminum powder. The coating thus produced may vary from 2 to 20 mils in thickness, has no interfacial layer, is porous, and is expensive to apply. The porosity of the coating does not interfere with its capacity to protect the steel against corrosion, but to better protect the iron from oxidation or scaling at high temperatures, it has been found desirable to use a suitable sealer.

The calorizing method consists of packing the steel products in a powder containing aluminum and ammonium chloride, and then heating in a neutral atmosphere to cause coating and impregnation to occur. This provides a layer many mils thick, and brittleness is overcome by a subsequent heat-treatment in the absence of additional aluminum, permitting further diffusion and reducing the aluminum content of the surface zone.

A modified calorizing method known as "alitizing" uses a 50 per cent iron-aluminum alloy in place of the powder, and requires no special atmosphere. The impregnated zone contains only 10 to 15 per cent aluminum, which possesses as good resistance to scaling as coatings with a higher aluminum content, and has improved ductility and adhesion.

Steel may be coated with aluminum by placing properly prepared sheets of steel and aluminum together and passing them in a heated condition through a rolling mill. Best results in bonding thin sheets by rolling have been obtained when aluminum sheet containing about 0.7 per cent silicon is rolled on a low-carbon (0.06 per cent) steel at a temperature around 400 F by a "sticking pass" of 40 per cent reduction. Both the aluminum and steel surfaces are roughened by scratch brushing before rolling. No intermediate anneals are used and the final anneal is carefully controlled between 995 and 1020 F to minimize the formation of interfacial layer.

Casting aluminum around steel has been utilized in the Alfin process where steel freshly coated with aluminum-silicon alloy is quickly placed in a mold and additional aluminum is poured around the steel. Thin coatings cannot be produced by this method, but it is used to produce massive sections of aluminum having a steel core or insert.

The fact that steel can be coated with aluminum in several ways, including these briefly mentioned, goes far to increase the usefulness—and the market possibilities—of both metals.

Mainspring Dynamometer

A DYNAMOMETER to record as a continuous trace the torque of a watch mainspring and barrel assembly was described by J. E. Hendricks, supervisor of physical research of the Hamilton Watch Company, Lancaster, Pa., during the 1950 ASME Fall Meeting in Worcester, Mass. The instrument graphically records the torque versus the degree of wind in both the wind and unwind directions.

Heretofore, Mr. Hendricks explained, dynamometers used in the watch industry employed a calibrated spring. However, such springs had proved unsatisfactory for, even though they were made of the highest-quality steel and manufactured to close tolerances, they were not reliable over a period of time and did not possess sufficient accuracy over the wide range of torque necessary for testing many different-size mainsprings.

Another principle, therefore, that of a weighted beam, was chosen, permitting the use of fixed masses, the weights of which would remain essentially constant. The principle involved was that of a "hunting" system, wherein a small weighted car placed on a beam, which was pivoted near one end, would be caused to move in a manner which would tend to keep the beam horizontal. To the one end of the beam would be applied, by means of a cord, the torque of the mainspring. As the torque increased raising the beam-end, the car would move away from the pivoted point until it caused an equal and opposite torque. The car was to be controlled by a lead screw running the length of the beam through a nut fastened beneath it. Two difficulties immediately arose: (1) A means of controlling the direction of rotation of the lead screw, and (2) a means of using the position of the beam to control this direction.

The first difficulty could not be overcome conventionally by any mechanical device. Since the beam pivoted, any connection to a motor placed elsewhere on the machine, such as a flexible shaft, would interfere with the balancing action, either directly or indirectly, by causing a change in the applied torque other than that caused by the moving car. Attaching a motor directly to the beam was unsatisfactory for two reasons: A motor of the required power and speed was too heavy to be so located, and it was desirable to have the motor which controlled the car also control the recording mechanism which would again involve a system of coupling.

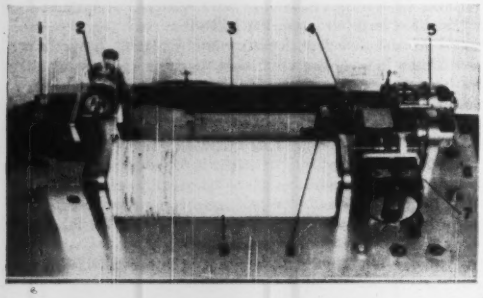

FIG. 6 MAINSPRING DYNAMOMETER SETUP

(1, Mainspring wind motor; 2, mainspring barrel holder; 3, beam; 4, weighted car; 5, autosyn motor; 6, autosyn transmitter; 7, reversible motor; 8, recording pen; 9, recording drum.)

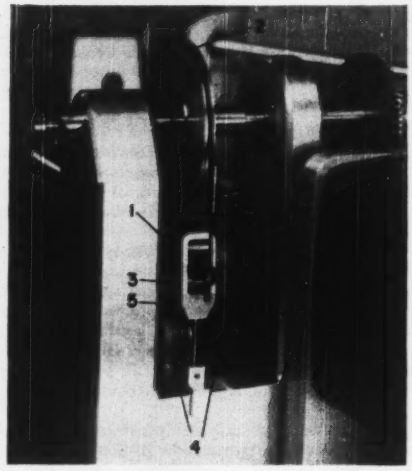

FIG. 7 BARREL-MOUNTING-DISK END OF DYNAMOMETER

(1, Beam; 2, mainspring barrel holder; 3, yoke; 4, electromagnet; 5, aluminum vane.)

A convenient method was found in the application of a pair of selsyn (self-synchronous) motors, of the type formerly used in aircraft instruments. One of these motors was sufficiently small to be mounted on the beam across the fulcrum point from the car. By using these selsyns, it was possible to connect electrically from the one which would be driven by a motor to the one on the beam, which would turn the lead screw. This method minimized interference with the balancing of the beam.

The second difficulty, controlling the direction of rotation of the motor which would drive the lead screw, posed a greater problem. Heretofore, contacts had been used on similar beams which actuated controlling relays. However, contacts get dirty, corrode, and constantly cause trouble; so a better method was sought.

Such a system was found in the "Electrolink" which uses the change in a magnetic field to operate control relays. An adaptation could be made by placing a vane on the beam which would cut a magnetic field to a greater or lesser extent as its position varied.

With these essentials established, the rest of the design was completed. Its principal components were a motor to drive the barrel arbor thus winding the mainspring, a pivoted beam to which the torque of the mainspring was applied, a movable weighted car which located itself on the beam to counteract the applied torque, a drive motor which moved the car along the beam through the intermediary elements of a selsyn motor, follower, and lead screw, and a control device which reversed the direction of the car drive motor at will depending upon the direction of unbalance of the beam.

The recording mechanism was designed after similar equipment already in use by incorporating a drum which revolved as the mainspring was wound and unwound and a pen which moved along the drum as the car was moved along the beam. A chart, commercial graph paper, could then be placed on the drum and the pen would trace out a curve the shape of which would depend upon the degree of wind or unwind of the spring and the position of the car as it moved to counteract the torque delivered by the spring.

A microswitch, controlled by a yoke placed over the end of

the beam to which the torque was applied, operated a relay which would reverse the mainspring wind motor. In this fashion the spring would wind until the torque increased at a rate faster than the car could counteract; at which point the pull of the spring would be sufficient to cause the beam to lift the yoke, closing the microswitch, and reversing the wind motor. The motor would then unwind the spring until the car returned to the pivot point.

In addition to a description of the mechanical features of the dynamometer, a description of the electrical and electronic portions was given by Mr. Hendricks. There is also a section devoted to some of the technical information that has been obtained as a result of the studies made with the equipment.

Mr. Hendricks pointed out that testing and analyzing the dynamometer has served to provide the Hamilton Watch Company with information heretofore unattainable although, in some cases, suspected. The machine has provided a means whereby critical testing of mainsprings is possible and has resulted in the production of mainspring assemblies having even flow of power and greater efficiency.

The complete paper, as presented by Mr. Hendricks, was published in full in the April, 1950, issue of *Instruments*, pages 351 to 356.

Water Velocity

THE use of ultrasonics to measure the velocity of water was described recently by W. B. Hess and S. K. Waldorf, senior test engineers, Pennsylvania Water and Power Corporation, Safe Harbor, Pa., and R. C. Swengel, York, Pa., consultant, before a meeting of the American Institute of Electrical Engineers in Baltimore, Md.

They said their experiments by ultrasonics of a method of determining the velocity, originally devised by Mr. Swengel, appeared applicable to large bodies of water and may lead to applying the method to large-scale measurements in the discharge of turbines at hydroelectric plants.

The ultrasonic method appears to have distinct advantages over existing methods of measuring the discharge of turbines in large hydroelectric stations, they reported. In carrying the method to the present state of development a great many difficulties have been overcome. It now appears that diligent effort can overcome the remaining obstacles in the way of applying the method to large-scale measurements.

The tests were made at the Holtwood Station of the Pennsylvania Water and Power Company, using water flowing from a roof storage tank.

The experiments were made on a small duct, 5 × 9 in. in cross section, with water velocities up to about 6 fps. The method consisted essentially of calculating water velocity from the measured phase angle between the transmitted ultrasonic signal and the signal received after passing through the body of moving water. The transducers used for the measurement were placed at the opposite walls of the duct and displaced some definite distance along the principal axis of flow. After progressive improvement in methods and equipment, errors of less than 2 per cent were obtained in measurements in the test duct.

It is very desirable that the discharge from the turbine of a hydroelectric unit be measured accurately under various conditions of loading so that the basic data may be obtained which will permit operating the generating station to extract the maximum power from the available water. Further, upon installation of a hydro unit, rating tests frequently are made to determine operating characteristics of the unit under various conditions of loading and whether contract specifications have been fulfilled. With existing methods of measuring turbine discharge, such tests usually require elaborate preparation of equipment and usually can be made only under special conditions which interfere with the normal operation of the plant. The ultrasonic method promises to be simpler for turbine testing, the authors state, and it appears that this method will require the installation of only relatively simple testing equipment.

Stainless Steel

A NEW stainless-steel alloy, USS 17-TV, which makes possible the commercial manufacture of larger, lower-cost, lighter-weight, more durable, rectangular television picture tubes, has been developed especially for video vacuum tubes by Carnegie-Illinois Steel Corporation. The principal objective of the research was to obtain a lower-cost, durable material for the production of metal-glass television picture tubes.

The rectangular television stage presents a full-screen picture similar in form to a movie screen and is becoming increasingly popular with the buying public. Successful rectangular screens with over-all areas as large as 325 sq in. are now practical.

When heated and cooled, glass and most metals expand and contract at different rates, causing the glass to crack when the two are sealed together. Thus it was necessary to develop a new stainless steel whose rate of expansion and contraction parallels that of glass. In addition, the steel had to be easy to form and strong enough to withstand the pressures caused by the vacuum inside the television tube.

A stainless steel containing 28 per cent chromium originally proved to be the only steel with expansion and contraction characteristics closely coinciding with those of glass. Additional development resulted in a new and less expensive stainless alloy containing approximately 17 per cent chromium. The 17 per cent chromium alloy answered most of the production and cost problems, but at the high temperatures needed to seal the glass and steel the expansion was too high. To overcome this hurdle the composition of the steel was adjusted. This corrected the rate of expansion and contraction.

The new steel is readily formed into the desired TV shape by spinning a disk of the metal into a round envelope from which the rectangular tube is produced. The envelope of a television tube acts as a spacer between the cathode-ray assembly and the glass screen on which the image appears.

Metal envelopes of USS 17-TV are more durable than all-glass for handling in manufacturing, shipping, or servicing. They also weigh substantially less than all-glass tubes.

Correction

IN the article "Packaging Test Chamber," which appeared in this section of the September, 1950, issue of MECHANICAL ENGINEERING, page 737, the following statement was made:

". . . hydrofluoric acid will burn the skin, but for surface shipment it is reasonably safe to put it into ordinary glass bottles packed in divided fiberboard cartons."

This statement is erroneous as hydrofluoric acid is a highly corrosive and caustic liquid and readily attacks glass. The word hydrofluoric was misinterpreted and should have been hydrochloric as hydrochloric acid is sometimes shipped in glass carboys.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Rubber and Plastics

Dynamic Shear Properties of Rubber-like Polymers, by I. L. Hopkins, Bell Laboratories, Inc., New York, N. Y. 1950 ASME Fall Meeting paper No. **50—F-24** (mimeographed; to be published in Trans. ASME).

A SIMPLE apparatus for determining the dynamic properties of elastomers in shear at audiofrequencies is appraised. Typical values of shear modulus and viscosity for several elastomers are given, both at room conditions and at 150 F. The frequencies of test range from 100 to 5250 cps, the shear moduli from 0.5×10^6 to 480×10^6 dynes per sq cm, and the viscosities from 20 to 75,000 poises.

While the precision of the method is not high, its simplicity and possible frequency range (which has not been exhausted in the present tests), and its yielding of data in terms of shear properties, recommend it for exploratory measurements. The advantage of the extended frequency range is manifest in avoiding the short-range conclusion that g and $\omega\eta$ are constants.

Comparative Strengths of Some Adhesive-Adherend Systems, by N. J. DeLollis, Nancy Rucker, and J. E. Wier, National Bureau of Standards, Washington, D. C. 1950 ASME Fall Meeting paper No. **50—F-15** (mimeographed).

THE strength properties of various adhesive-adherend combinations were determined as one phase of an investigation of the nature of adhesion. The adhesives were polyvinyl acetate, cellulose nitrate, resorcinol resin, casein, gum arabic, natural rubber, and neoprene. The adherends were stainless steel, aluminum alloy, paper-phenolic laminate, glass, birch wood, and hard rubber. The properties studied were double-lap shear, tensile, long-time loading shear, and impact strengths.

The tensile-adhesion and shear strength values for a given adhesive-adherend combination did not differ greatly except for wood and paper-phenolic laminate, which are nonisotropic. The highest values (up to 3600 psi) were obtained with polyvinyl acetate and cellulose nitrate adhesives.

The thermosetting resorcinol resin showed no appreciable flow in supporting a load of 680 psi for 6 months, whereas the thermoplastic polyvinyl acetate failed in 45 days under a load of 200 psi.

The rubber-type adhesives which were weak compared with the other adhesives in the static load tests were definitely superior in the impact tests.

Better correlation of shear strengths was observed with the moduli of elastivity than with the dielectric constants of the materials used in the various adhesive-adherend combinations.

Ultrasonic Testing

Ultrasonic Flaw Detection in Pipes by Means of Shear Waves, by C. D. Moriarty, General Electric Company, Schenectady, N. Y. 1950 ASME Fall Meeting paper No. **50—F-14** (mimeographed).

THE annular cross section of pipes does not lend itself to adequate inspection for flaws by means of normal ultrasonic methods. This is especially true where it is suspected there are radial-type flaws extending axially, that is, defects whose dimensions are usually greater in a radial direction than in a circumferential direction, such as radial cracks or folds. The need for an ultrasonic method to detect this type of flaw in pipes is evident when it is realized that under internal pressure this orientation would weaken the pipe. General Electric has recently developed a procedure by which ultrasonic shear waves can be used for such detection.

There are three major types of ultrasonic waves which can be used in flaw detection: Longitudinal, which is at present in common use; shear, which has only recently been applied to inspection problems; and surface, which has not yet been applied to much routine inspection. Of the foregoing types, only longitudinal and shear waves penetrate into metal and become useful as a means of finding subsurface flaws.

This paper describes a procedure by which ultrasonic methods can be applied to the inspection of high-pressure piping.

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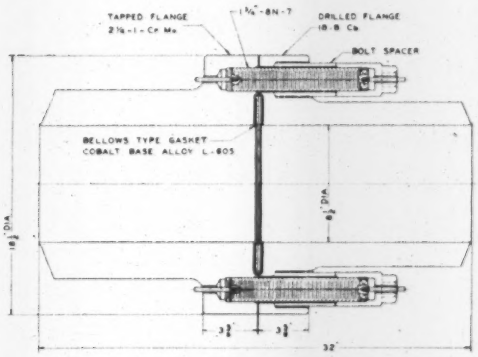
A description of the equipment used is included together with some basic information by which the applicability to general pipe inspection can be evaluated.

Steam-Power Generation

Joints for High-Pressure High-Temperature Piping, by I. H. Carlson and W. S. Black, Jun. ASME, Crane Company, Chicago, Ill. 1950 ASME Fall Meeting paper No. 50—F-32 (mimeographed).

OPERATING engineers have long been troubled with leaks in pipe joints and as a direct result, wherever possible, welding has become an answer in most cases. However, it is the judgment of some that piping of different expansion characteristics whether of the same material or of different materials shall not be welded to form the joint. There is also a need for mechanical joints where the piping must be disconnected from equipment.

It may not be generally appreciated that temperature stresses are often several times as much as that permitted by code formulas which are based on pressure forces alone and have not yet included factors to indicate the extent of stresses created by differential expansion. The importance of this problem has been emphasized in at least two papers which have appeared before the Society. A temperature differential of only 150 F between two points in a steel mass may produce a stress of 30,000 psi.



SECTIONAL VIEW OF BELLOWS-TYPE JOINT

The difficult problems of obtaining leakproof joints for high-pressure high-temperature piping are outlined. It includes the results obtained from an extensive test on three full-size joints for connecting ferritic alloy main steam piping to austenitic alloy turbine equipment of 150,000 kw capacity. The scope of the tests was limited by the amount of steam available, but the information secured should be of value to others having similar problems.

Trend of Power-Plant Practice in Germany, by L. F. Musil, Styrian Hydro and Electric Power Corporation, Graz, Austria. 1950 ASME Fall Meeting paper No. 50—F-21 (mimeographed).

THE trend in the heat rates of German power plants from 1915 to 1945 indicates several distinct periods. The first period, up to 1925, is characterized by the use of low steam pressures and temperatures, 200 to 300 psi, and 600 to 650 F. The second, from 1925 to 1928, shows the effect of the adoption of intermediate pressures and higher steam temperatures, 450 to 600 psi, and 800 to 850 F, as well as the use of stage feedwater heating and of the pulverized-coal-fired furnace, first employed at Klingenberg Station in Berlin.

In 1928 the first experiment on a commercial scale was made with high steam pressure, 1300 psi and 910 F, and reheating with live steam, at the topping plant of the Mannheim Power Corporation in Mannheim. This installation was followed by topping plants similar in design, except for the use of flue-gas reheating.

Beginning about 1936, steam pressures for the new condensing power stations rose to the range of 800 to 1100 psi with corresponding temperatures 880 to 930 F. Shortly thereafter pressures of 1600 to 1800 psi, with gas reheating, were adopted by such plants as Pomerensdorf in 1937, Mannheim in 1940, and by the standardized war plants in 1943.

Over the 30-year period from 1915 to 1945, average station heat rates improved from 24,000 to 11,550 Btu per kwhr, the latter figure applying to plants located adjacent to a natural supply of condenser cooling water. For plants requiring artificial cooling, the corresponding rate is 11,700 Btu per kwhr. These rates are based on the net energy delivered to the transmission lines. Since the end of World War II some power plants in Germany have gone to still higher temperatures, 1020 F, and 1110 F is at present under consideration.

This improvement in station heat rates has occurred in spite of a deterioration in the quality of coal available to the power plants. In addition to the large percentage of brown coal, lignite, burned in German boilers, 55 per cent in 1940, 33 per cent in 1949, there has been a substantial increase in the consumption of waste coal originating at separation plants, the better grades being used for other purposes.

The paper covers such topics as (1) the basic considerations of power-plant design, (2) factors influencing the structural design of central stations, and (3) status of power-plant standardization.

Trends in Modern Boiler Control, by J. F. Luhrs, Bailey Meter Company, Schenectady, N. Y. 1950 ASME Fall Meeting paper No. 50—F-17 (mimeographed).

FOUR definite trends have appeared in modern boiler and power-plant design which have presented interesting and sometimes complex control problems for solution. These trends are: (*a*) Multiple fuel firing, (*b*) higher pressures and temperatures, (*c*) control of boiler-water level by varying pump speed in plants of unit design, (*d*) centralized control rooms. This paper discusses the control problems presented by these trends.

The Use of Tungsten Carbide in Coal Pulverizers, by Wayne C. Rogers, Mem. ASME, Riley Stoker Corporation, Worcester, Mass. 1950 ASME Fall Meeting paper No. 50—F-22 (mimeographed).

THE procedure of burning pulverized coal involves (*a*) grinding of the raw coal in a coal pulverizer, (*b*) the carrying of the pulverized fuel in a current of primary air delivered by an exhauster fan through pipes to the burners, (*c*) mixing of the fuel and the primary air with additional secondary air in the burners, (*d*) blowing the mixture into the furnace where it is burned in suspension.

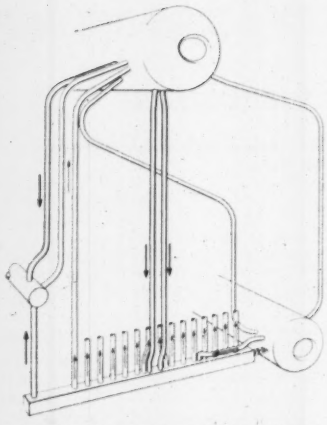
The well-recognized advantages of this type of firing are offset to some extent by the large initial capital investment required plus the inherent high cost of operating and maintaining the milling equipment.

This paper describes the application of an extremely wear-resistant material, tungsten carbide, as a protective facing for pulverizer grinding elements which are subject to wear and frequent costly replacement. Existing pulverizers which have together ground upward of one million tons of coal using this material have shown a significant decrease in maintenance costs due to reduced wear of grinding parts. Pulverizer designs modified to take full advantage of the properties of the new material and recently put into service in the field give evidence that further reductions in maintenance may be expected, as well as decreased power requirements, without increased initial capital investment in milling equipment.

Standardized Boiler Units, by Carl E. Miller, Combustion Engineering - Superheater, Inc., New York, N. Y. 1950 ASME Fall Meeting paper No. **50—F-33** (mimeographed).

A STANDARD boiler is considered as one which has been completely designed in reasonable-size increments to take care of various space conditions and the various fuels and methods of firing. Essential information such as boiler size, fuel-burning equipment, fuel flexibility, and performance are all tabulated information. Drums, tubes, headers, arrangement of heat-absorbing surface, soot blowers, and casings have all been worked out and completely detailed. Blueprints are available which are sent to the customer and shop immediately on receipt of an order. Many of the standard parts are already in a regular shop schedule so that maximum advantage is taken of the most efficient methods of production. An adequate stock is maintained of other essential items so that delivery can be expedited.

Most standard designs are built in the smaller capacities and for low pressure and moderate superheat, and the following generalities are approximately correct: The standard boilers, i.e., those requiring negligible engineering time, are available in capacities up to about 60,000 lb of steam per hr. These are generally for operating pressures in the range of from 100 to 400 psi. Usually, they are built to supply saturated steam only, but standard superheaters to give nominal superheat are available in a number of designs. Various types of stokers are



CIRCULATORY SYSTEM STANDARD WATER-TUBE BOILER

used depending on the capacity of the unit. Oil and gas firing is used for all sizes. Below 30,000 lb of steam per hr, the single-retort underfeed stoker is most common. Above that capacity, either the spreader stoker or traveling grate is usual. Pulverized fuel is not used because of the difficulties in economically attaining adequate flame travel and sufficient cooling of the flue gas to avoid slag deposits in boilers of this low-capacity range.

At the present time, above 60,000 lb per hr, standardized types of boilers are generally available. In these, some parts are completely standardized to reduce engineering costs and time. Other parts are individually designed to fit the particular requirements of the installation under consideration.

This paper discusses certain basic principles of any properly designed standardized boiler, and illustrates by examples a few of the types of standardized construction.

The Steam Lift in a Hot-Process Water Softener, by A. A. Kalinske and J. M. Kahn, Infilco, Inc., Chicago, Ill. 1950 ASME Fall Meeting paper No. **50—F-29** (mimeographed).

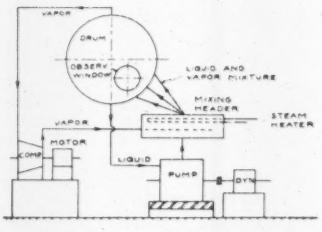
IN order to obtain the full advantages of rapid mixing, flocculation, and conditioning of the precipitates formed in the hot-process softener solids, contacting of the raw water and chemicals with previously formed precipitates was incorporated in a hot-process softener similar to what is done in a cold-process high-rate treating unit. This was accomplished by circulating slurry, using the steam-lift principle of pumping. The use of a steam lift for pumping the slurry and circulating it in the manner described, automatically resulted in deaerating the raw water. Therefore the application of the steam lift to a hot-process softener for producing slurry circulation makes it possible to eliminate the raw-water deaerator. Design criteria for such a steam-lift deaerating hot-process softener were established from pilot-plant studies. The operation of a full-scale installation under practical operating conditions has confirmed the fact that steam-lift circulation of slurry is practical and beneficial in a hot-process softener, resulting in more efficient use of chemicals, particularly in effecting silica reduction.

Investigation of Steam Separation in Boiler Drums Through Studies On a Model, by Erich A. Farber, University of Wisconsin, Madison, Wis. 1950 ASME Fall Meeting paper No. **50—F-25** (mimeographed).

THE present trend of increasing the output, operating temperature, and pressure of steam generators or boilers has caused steam operation to become one of the leading problems in power-plant engineering.

Steam generators are designed by men with years of experience, drawing on actual performance data of similar units. After a steam generator is built, any changes which have to be made to improve its performance are very costly.

This investigation shows a method by which the performance of steam-boiler-drum internals can be compared and predicted. The method is based on tests carried out with a model filled with Freon 12 as liquid and vapor, and gives the same density ratio between liquid and vapor which exists in the boiler. When the velocity of the liquid-vapor mixture in the model drum is adjusted to the proper value, then the separation forces in the model and boiler are the same. Freon 12 was selected after tests with water and air had been made but proved to be



SCHEMATIC ARRANGEMENT OF THE MODEL BOILER AND ACCESSORIES

insufficient. The experiments were performed at different loads, pressures, and liquid levels in the drum. Several different drum internal arrangements were tested and results and conclusions based on these tests are reported in this paper.

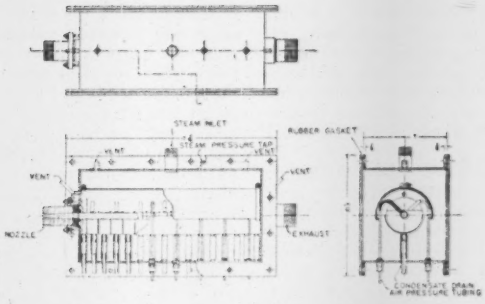
Flow of a Flashing Mixture of Water and Steam Through Pipes and Valves, by W. F. Allen, Jr., Stone & Webster Engineering Corporation, Boston, Mass. 1950 ASME Fall Meeting paper No. 50—F-27 (mimeographed; to be published in Trans. ASME).

THE design of piping, such as the cascade drain lines between feedwater heaters which convey initially saturated liquid from a source at one pressure to a receiver at a lower pressure, has been a perplexing problem. Experience has proved that sizing valves and piping for this service by the usual criteria for liquid flow is unsatisfactory. The alternate procedure of sizing by empirical formulas or arbitrary selection not only is costly but, more important, offers no guarantee that the resultant capacity of the piping system will be adequate.

A simple method, therefore, is presented of designing piping and valves, particularly heater drain piping, to carry a flashing mixture of water and steam. Rational design formulas are derived from the energy, continuity, and dynamic equations on the basis of an assumed uniform mixture at any point in the path of flow. Earlier papers have predicted and experimentally verified the existence of a critical pressure, under certain conditions, at the end of a pipe carrying a flashing mixture. Results calculated from the derived formulas compare favorably with these published test data. It is noted that if the initial assumption of a uniform mixture is not fulfilled, the limitations imposed on the piping are less severe than for the uniform mixture case, as the capacity of both valves and pipes will be greater than predicted by formulas. A scheme is suggested for eliminating flashing completely in heater drain systems employing drain coolers.

Heat Transfer

Report of Progress on Measurements of Friction Coefficients, Recovery Factors, and Heat-Transfer Coefficients for Supersonic Flow of Air in a Pipe, by Joseph Kaye, Jun. ASME, J. H. Keenan, Fellow ASME, and W. H. McAdams, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1950 ASME Fall Meeting paper No. 50—F-13 (in type; to be published in Trans. ASME).



TEST PIPE AND JACKET FOR HEAT-TRANSFER TESTS

MEASURED values are presented for friction coefficients, recovery factors, and heat-transfer coefficients for a stream of air flowing through a pipe at Mach numbers ranging from 2.5 to 1.2. The friction coefficients are in good agreement with those of Keenan and Neumann. At a diameter Reynolds number at inlet of about 1×10^6, which is intermediate between values observed by Keenan and Neumann, frictional effects of a very low order were observed. Maximum frictional effects occurred at a diameter Reynolds number at inlet of about 1.5×10^6. Friction coefficients are, in general, considerably lower than those for fully developed turbulent flow of incompressible fluids at the same values of the Reynolds number.

For laminar boundary layer, it appears that the recovery factor is in close agreement with the results of the Pohlhausen analysis, namely $(\mathrm{Pr})^{1/2}$ or 0.865. For turbulent boundary layer the recovery factor appears to vary from about 0.79 where the Mach number is 1.3 to about 0.865 where the Mach number is 2.2. It cannot be determined from the present tests whether this variation is primarily an effect of variation in Mach number, although it probably is.

The measured values of heat-transfer coefficient in the region of laminar boundary layer seem to be roughly in accord with the Pohlhausen analytical values for incompressible flow over a flat plate. In the region of greatest turbulence in the boundary layer, agreement with the McAdams correlation of data for turbulent flow in pipes is good. The major portion of the data obtained appears to be in the region of transition in the boundary layer from laminar to turbulent flow. Most of the observed values of heat-transfer coefficient are smaller by far than the corresponding ones for fully developed turbulent flow—the ratio of one to the other being as small as 1 to 10.

Heat Transfer Through Gases at Low Pressures, by R. E. Peck, Illinois Institute of Technology, W. S. Fagan, Argonne National Laboratory, and P. P. Werlein, Illinois Institute of Technology, Chicago, Ill. 1950 ASME Fall Meeting paper No. 50—F-16 (in type; to be published in Trans. ASME).

THE purpose of this study is to determine experimentally the heat transfer between two parallel vertical plates. The space between the plates is filled with a gas at low pressure, and the boundaries of this gas layer are enclosed by a solid heat insulator. The variation of this heat transfer with pressure, temperature difference, type of gas, and thickness of the gas layer is determined. The experimental result is compared with both theoretical and empirical equations.

This result is

Helium:

$$Nu = 8.0\ Gr^{0.04}\ (L'/H)^{0.75}\ 10^{-2} < Gr < 5 \times 10^3$$
$$h = 9.2\ kP^{0.080} \qquad 1 < P < 760 \text{ mm Hg}$$

Air:

$$Nu = 14.1\ Gr^{0.022}\ (L/H)^{0.75}\ 10^{-1} < \mathrm{Gr} < 5 \times 10^3$$
$$h = 17.1\ kP^{0.083} \qquad 1 < P < 100 \text{ mm Hg}$$

NOTE: P in mm Hg, h/k in ft^{-1}

Pressure Drop and Heat Transfer for Subsonic Air Flow in a Smooth Pipe, by W. Goldsmith, Jun. ASME, and R. A. Seban, Jun. ASME, University of California, Berkeley, Calif. 1950 ASME Fall Meeting paper No. 50—F-18 (mimeographed).

THE flow behavior of air has been studied in a 0.586-in-diam electrically heated tube approximately 20 ft long in the subsonic region. Provision of sectional guard heaters insured a good approximation of a boundary condition of uniform heat transfer. The range of the pertinent variables are the following: (1) Flow rate, 45 to 95 lb per hr; (2) wall temperatures, 70 to 350 R; (3) Reynolds numbers, 28,000 to 50,000; (4) Mach

numbers, 0.22 at entrance to 1 at exit.

A theory is developed covering the foregoing case which, under certain idealizations, leads to a differential equation most readily solved by the isocline technique. From this curve, pressure drops may be computed as a function of pipe length.

A comparison of the theoretical prediction with experimentally determined pressure distributions indicates reasonable agreement when variations in heat rate are accounted for by sectional splitting of the tube into portions over which uniform heat transfer may be presumed to exist. Discrepancies still evident in the result may be accounted for entirely by an error of 5 per cent of the assumed value of the skin-friction coefficient.

Both skin-friction and heat-transfer coefficients indicate a decreasing trend with pipe length, amounting to ±8 per cent and ±10 per cent, respectively, from the mean value.

Correlations of the mean values of the skin-friction and heat-transfer coefficients with accepted empirical relations indicate satisfactory correspondence.

Management

Increasing the Competitive Position of Your Company Through Better-Trained Personnel, by D. F. Lane, Mem. ASME, Baltimore, Md. 1950 ASME Fall Meeting paper No. 50—F-2 (mimeographed).

IN order to increase productivity output per man-hour and improve competitive position, every effort should be made to develop management people with the highest qualities of executive leadership, administrative intelligence, and eternal vigilance. The new leader should come up from the bottom as it is only by this route that understanding to real leadership can be developed in the leader himself.

With turbulent unions and the impact of competition pressing down on many industries, top management should take an active part in providing first-line supervisors with adequate management information which will enable them to discharge their respective responsibilities with the greatest degree of efficiency.

Executives should launch a strategy of co-operation with working personnel by attempting to provide workers with economic security and job satisfaction in return for increased production and good profits. The greatest single factor in the productivity of the individual is his mental attitude toward the job, the boss, and the company. If it is favorable, his output improves; when it is unfavorable, production often suffers. Therefore progress should be made in establishing rapport with plant workers. One of the best means of achieving mass understanding is to provide broad lines of communication from the top echelon level to the rank and file and vice versa. Such disseminative information should be written or imparted to workers in a convincing manner, so that they will respond with favorable attitudes.

While training of personnel is one of the most expedient and economical means of improving the competitive position of any company, it will not happen by chance—the American industrialist must take deliberate action. A well-trained organization is the best guarantee of an assured future.

The Dynamics of Education and Training, by W. L. Ganong, H. P. Hood, and Sons, Boston, Mass. 1950 ASME Fall Meeting paper No. 50—F-7 (mimeographed).

THE caliber of the people in an enterprise determines the degree of success it enjoys. A sound training philosophy and the use of proved methods are the surest approach to the development of better qualified personnel. This paper outlines the forms training may take, basic reasons for training, factors that guide successful training, and a suggested pattern that leads to more effective training activities.

Machine Design

The Design of Nonlinear Leaf Springs, by S. P. Clurman, Sperry Gyroscope Company, Great Neck, L. I., N. Y. 1950 ASME Fall Meeting paper No. 50—F-5 (in type; to be published in Trans. ASME).

IT is occasionally desirable to incorporate into a mechanism a spring having a particular nonlinear force-deflection relationship. This need may arise in the design of computers, certain control mechanisms, and special shock-absorbing systems. A technique is developed whereby leaf springs may be designed to follow arbitrary functions having increasing first derivatives. Some experimental results are discussed. A device is described which will produce a spring characteristic having a decreasing first derivative.

The equations developed in this paper are presented as approximate ones. The closeness of solutions obtained by them to the results required will vary, depending upon the particular functions and parameters involved. In many cases the design obtained directly from the theoretical calculations will be satisfactory. In other cases where the required accuracy is too high, the theoretical solution will serve admirably as the first approximation in a cut-and-try experimentation. The theoretical solution is a convenient first approximation since its error will always be in the direction of being too stiff. By shaving down the contour of the base block, the test results can be brought very close to the ideal characteristic.

The finished design will have the advantages for manufacturing purposes, in most cases, of requiring only a close dimensional inspection, rather than a point-by-point checking calibration.

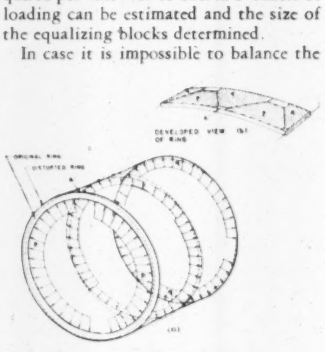
On the Design of Rotor-Coil Support Rings, by J. J. Ryan, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1950 ASME Fall Meeting paper No. 50—F-6 (in type; to be published in Trans. ASME).

THE construction of large-capacity turbogenerators has placed greater importance upon the evenness of the distribution of the field coils under the rotor-coil support rings. This paper discusses the increase in stresses in the ring due to uneven distribution of the coils, describes a photoelastic investigation for the purpose of checking the theoretical analysis, and suggests that uniform distribution of the coils would reduce the stresses in the rotor-coil support ring.

This could be accomplished by increasing the length of the support ring an adequate amount to allow the axial spacing of the end turns to equal the circumferential spacing of the slots. However, this solution is impractical because of the increase in length of the rotor.

It may be necessary to add additional stress-equalizing blocks of an insulating nature, such as transite, between the coils in the axial direction parallel to the slots. The weight of the material required per unit area to obtain evenness of loading can be estimated and the size of the equalizing blocks determined.

In case it is impossible to balance the



DISTORTIONS OF ROTOR-COIL SUPPORT RING

loading on the rotor-coil support ring, an increase in the thickness of the ring is an effective means to reduce the stresses and deformations.

Production Engineering

Residual Grinding Stresses in Mild Steel, by J. Frisch, Jun. ASME, and E. G. Thomsen, University of California, Berkeley, Calif. 1950 ASME Fall Meeting paper No. 50—F-10 (in type; to be published in Trans. ASME).

A METHOD for determining residual surface stresses is presented. For their determination, it is necessary to remove small layers from the part which has been bent by the residual stresses in the unrestrained state, and to measure the resulting change in deflection and thickness of metal removed. Etching with a weak nitric acid and water solution was found to be a satisfactory method for removing surface metal without introducing additional stresses. Mild-steel bars were ground with a medium-soft grinding wheel in a surface grinder. The depth of surface layer containing residual stresses extended to approximately 0.012 in. to 0.018 in. below the surface for grinding cuts ranging in depth from 0.0003 in. to 0.003 in. The thickness of the layer containing residual stresses increases with increasing depth of grind. The maximum residual stress occurs on the surface and, for all depths of grinds, was considerably above the yield point of the original material. The maximum surface stresses when grinding mild steel within the foregoing range of depth of cut decreases with increasing depth. It is believed that this phenomenon can be explained by the possible partial recrystallization of the surface grains because of the higher surface temperatures obtained with heavy cuts.

Design of Lanchester Damper for Elimination of Metal-Cutting Chatter, by R. S. Hahn, Mem. ASME, The Heald Machine Company, Worcester, Mass. 1950 ASME Fall Meeting paper No. 50—F-11 (in type; to be published in Trans. ASME).

THOSE who are concerned with the machining of metals with single-pointed tools are often confronted with a self-excited vibration, commonly termed chatter, during the cutting process. This difficulty is especially acute when the rigidity of the tool or work-holding structure is relatively small, such as when boring long holes with a single-pointed tool mounted at the free end of a boring bar or quill.

A Lanchester damper for eliminating chatter of boring quills is shown. The rate of decay of free vibrations of the quill is found to be of importance in chatter. The free vibrations of a single-degree-of-freedom system with a viscously coupled Lanchester damper attached are analyzed, yielding a chart from which the optimum coupling can be determined. The damping characteristics of thin air films are discussed.

Gas-Turbine Power

Combined Steam and Gas-Turbine Processes, by W. M. Rohsenow, Jun. ASME, and G. H. Bradley, Jr., Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1950 ASME Fall Meeting paper No. 50—F-23 (mimeographed).

AS the importance of the gas turbine grows, it becomes increasingly necessary to analyze many different arrangements of component parts to determine which will give the best possible operating characteristics for the conditions of their use. Such factors as size, weight, efficiency, and initial cost all play an important role in such an analysis. The engineer generally must design his equipment on an economic basis. He must also keep in mind the limiting conditions, the most important of which is the strength of gas-turbine material at high temperatures. The present investigation is an analysis of gas-turbine processes which makes use of water in various ways. In order to study the relative merits of the various arrangements a comparative analysis was made.

Processes investigated included: (1) Ordinary gas-turbine power plant; (2) combined steam and gas-turbine process; and (3) gas-turbine process with water injection in the combustion chamber.

The results show that, in general, as complexity increases, the efficiency goes up, the specific flow rate goes down, the work ratio goes up, and the pressure ratio remains about the same. These factors tend to produce smaller units for a given net power output, but the number of component parts is increased. It is possible that decreasing the individual equipment size would offset the increase in complexity. This of course must be studied from an economic point of view.

Wood Technology

Furniture Design From the Standpoint of Lumber Utilization, by Frank T. Parrish, Heywood-Wakefield Company, Gardner, Mass. 1950 ASME Fall Meeting paper No. 50—F-31 (mimeographed).

THE lumber cut has too frequently been the general measuring stick for furniture production rather than the correct factor of net footage cut or yield. Lumber waste that had been methodically reduced through careful study and practice during the late thirties to perhaps the lowest point in history, soared in the late forties to a new high for recent years.

Management has become aware of this costly lumber waste and cognizant of the fact that to get more furniture production, something other than just cutting more lumber is required. The findings of tests made today are somewhat different from those of previous studies. The high waste is not due to the accepted fact that the better grades of prewar lumber with the long clear cuts are lacking. The reason—a growing scarcity of the higher grades of lumber and a greater percentage of the lower grade in every load.

From this it is apparent that the old approach of trying to reduce the lumber waste percentage or to improve the yield by studying such things as the cut-off operations or the ripping and matching methods, or even better lumber-handling and kiln-drying practice would gain very little.

This paper, therefore, reports on obtaining the maximum lumber utilization through a co-ordinated effort of design and development.

Progress in the Development of Synthetic Board Materials From Wood Waste, by Robert A. Caughey, Souhegan Milis, Wilton, N. H. 1950 ASME Fall Meeting paper No. 50—F-26 (mimeographed).

ASIDE from its major use as fuel, wood waste potentially forms the basis of several new wood-converting industries capable of tremendous growth, and which may have a pronounced effect on the national economy.

This paper deals with the production from waste wood of synthetic board materials having properties comparable with those of wood, and involving the use of synthetic resins for bonding small particles of wood, such as sawdust or shavings, together. This is in distinct contrast to the manufacture of soft insulating board, or hard board, both of

which depend on the felting of wood fibers, under various conditions of heat, moisture, and pressure.

Basically, operations involved in making resin-bonded board materials are simple. Relatively finely divided wood, such as shavings or sawdust, are mixed with an active synthetic resin of the thermosetting type. The mixture is spread in a uniform layer on a suitable tray, which is then inserted between the platens of a hydraulic press, where heat and pressure are applied until the resin is cured. The board is then extracted from the press and, when cool, treated much as lumber or plywood. A tremendous range of physical properties may easily be obtained, depending on the amount of resin, the degree of pressure, and the configuration of the wood particles, and to a lesser extent on the type of resin and species of wood. At the present time there is little doubt but that a synthetic board can be made for most of the applications where wood is now used, often doing a better job than lumber is now doing.

Steel Used in the Cutting of Wood, by H. A. Pavitt, Simonds Saw and Steel Company, Fitchburg, Mass. 1950 ASME Fall Meeting paper No. **50—F-30** (mimeographed).

A NUMBER of steels are used in the cutting of wood, inasmuch as wood is cut in many ways and for many purposes. Since the woods themselves vary greatly in their properties, many requirements are placed on the cutters. To satisfy these many requirements, it has been necessary to employ the use of carbon steels, low-alloy carbon steels, intermediate-alloy steels, and high-alloy steels. Where requirements and conditions permit, carbides are being employed.

In the manufacture and use of any of these woodworking tools, we are faced with a compromise between hardness, resistance to abrasion, toughness, filability, grindability, resistance to tempering, etc. By way of example, a circular wood saw could be made harder. As a result of this increased hardness, the saw would have greater abrasion resistance and, therefore, retain a keen edge longer, that is, if the saw did not burst or crack as a result of low notch sensitivity or toughness. Further, greater care would have to be exercised in the grinding of the saw, otherwise incipient cracks would be established, causing early failure. To overcome such shortcomings, it is necessary to reduce hardness and increase toughness so that while the saw does not maintain a keen edge as long and becomes dull, it does have the ability to be resharpened without cracking. Regardless of how steels are used, it appears that compromises of properties must be made. Therefore steels are selected which require a minimum of compromise.

Safety

Dust Hazards Relative to Grinding Operations, by K. T. Benedict, Norton Company, Worcester, Mass. 1950 ASME Fall Meeting paper No. **50—F-8** (mimeographed).

DUST hazards do exist in grinding operations. They are quite well understood and controlled generally. Potential health hazards may arise from three sources. Dust is thrown off from the grinding wheel or tool as it is worn down. Dust arises from the material upon which the grinding is being done. These dusts, defined as fine dry particles of matter so comminuted that they may be raised and wafted by the wind, may also be dispersed on volatile coolant droplets or spray. They may be abrasive, metallic, or inorganic.

Diseases may result from such operations. Some are annoying. Some may be death dealing. All are expensive. They cost the company money in lost time, lost skills, and in compensation charges. They may cost the man money in lost pay, sickness expenses, and suffering. Sometimes they cost him his life. In all instances industry wants to rid itself of these hazards.

Dust hazards relative to grinding operations in the machine division of a large abrasive manufacturing company have been surveyed.

Grinding machines, allied operations, and artificial grinding wheels, in general, have been studied. Causes of pneumoconiosis or the so-called "dusty lung," have been reviewed relative to grinding operations.

Thirty-two men from 26 to 60 years of age, exposed to dust hazards of grinding operations in the machine division and two men who have been working in a truing department of the abrasive division of a large abrasive manufacturing plant have been studied for dust-hazard diseases. They have operated a wide variety of grinding machines. Dust counts have been consistently low even for free silica exposure, to say nothing of the maximum allowable concentrations of 50 mpcf for nuisance dusts of which many grinding wheels are made. Lung examinations including chest x rays reveal no cases of tuberculosis, silicosis, or benign pneumoconiosis.

Dust eye hazards are present but no severe injuries or prolonged disabilities were noted. Adequate eye protection, in the form of company-furnished safety glasses, is urged, but not forced upon the worker. Co-operation, by education, is achieved.

No cases of dermatitis were observed during the studies.

ASME Transactions for October, 1950

THE October, 1950, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Furnace Heat Absorption in Paddy's Run Pulverized-Coal-Fired Steam Generator, Using Turbulent Burners, Louisville, Ky.:

Part I Variation in Heat Absorption as Shown by Measurement of Surface Temperature of Exposed Side of Furnace Tubes, by R. I. Wheater and M. H. Howard. (49—A-118).

Part II Furnace Heat-Absorption Efficiency as Shown by Temperature and Composition of Gases Leaving the Furnace, by R. C. Corey and Paul Cohen. (49—A-42)

Part III Comparison and Correlation of the Results of Furnace Heat-Absorption Investigation, by H. H. Hemenway and R. I. Wheater. (49—A-117)

Discussion of Preceding Papers

The Evaluation of Steam-Power-Plant Losses by Means of the Entropy-Balance Diagram, by Allen Keller. (49—A-65)

The Gas-to-Gas Heat Exchanger as Applied to an Oxygen Plant, by Clyde Simpelaar and David Aronson. (49—A-153)

Design of Regenerators for Gas-Turbine Service, by David Aronson. (49—A-144)

Correlation of Plastic Deformation During Metal Cutting With Tensile Properties of the Work Material, by J. T. Lapsley, Jr., R. C. Grassi, and E. G. Thomsen. (49—A-121)

Improved Nails, by E. George Stern. (49—A-115)

Head and Flow Observations on a High-Efficiency Free Centrifugal-Pump Impeller, by W. C. Osborne and D. A. Morelli. (49—A-108)

The Flow Through Centrifugal Compressors and Pumps, by H. E. Sheets. (49—A-154)

Possibilities of the Regenerative Steam Cycle at Temperatures Up to 1600 F, by P. H. Knowlton and R. W. Hartwell. (49—A-33)

Oil Holes and Grooves in Plain Journal Bearings, by S. A. McKee and H. S. White. (50—S-9)

Film Thickness Between Gear Teeth, by M. D. Hersey and D. B. Lowdenslager. (50—S-10)

Thermal-Shock and Other Comparison Tests of Austenitic and Ferritic Steels for Main Steam Piping, by W. C. Stewart and W. G. Schreitz. (50—S-23)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Thermal Cracks in Turbine and Generator Rotor Forgings

COMMENT BY J. T. JARMAN[1]

The authors[2] have selected a difficult subject and for the first time have organized and assembled data such that a pattern for investigation can be followed.

Ingots for many forgings for the purpose indicated in this paper are large and frequently subject to defects, as illustrated in Fig. 8(*b*) of the paper. Many times it has been difficult or impossible to judge the hidden effect of these nonmetallic clusters unless the forging was "bottle" bored or scrapped.

We are in full agreement with the authors that forgings with thermal cracks must be scrapped and feel that it is extremely important to be able to judge correctly when such a condition is suspected. The authors' correlation of experience and ultrasonic tests is the first to be published on this type of forging and will serve as valuable pioneer contribution to this art of inspection.

COMMENT BY J. W. PRICE, JR.[3]

We in the forging industry consider turbine and generator forgings as requiring the highest quality it is practical to produce, and this rather early use of ultrasonics offers an indication of the care which must be used in their manufacture and inspection. It is interesting to note that magnetic particle testing also had as one of its earliest applications the inspection of turbine and generator forgings.

As a forging manufacturer, we too have installed ultrasonic testing equipment, and the principal problem in its use has been the interpretation of the indications seen on the oscilloscope trace. The examples discussed in this paper show clearly how the authors have used this method of testing as a means of locating questionable areas and have then explored these areas by conventional means. It is believed, as with any new method of testing, this represents the only sound approach to its proper application.

The equipment we are using offers variable frequencies of testing from $^1/_2$ megacycle to 5 megacycles, and it is our experience that the frequency employed can affect materially the results obtained. For example, we have found that, as the frequency of testing is increased, there is an increase in the tendency for coarse structures such as coarse pearlite or coarse grains to absorb the vibration. This tends to make the use of higher frequencies undesirable; however, when using a frequency of 1 megacycle, such as employed by the authors, we do not generally get flaw reflections as large in comparison to the back reflections as those shown in this paper. Do the authors believe that this may be affected by the strength of the pulse?

We are also interested in the reflections they have obtained from inclusions of the type they have shown in Fig. 8(*b*), since we have never encountered this in our experience. We are unable to obtain sharp reflections from such inclusions at a 1-megacycle frequency of testing and, at a $2^1/_4$-megacycle frequency, the inclusions appear to absorb rather than reflect the vibrations.

The authors are to be commended for their excellent illustration of how a new method of testing such as this may be used to advantage to locate questionable areas and then to explore these areas by conventional means.

COMMENT BY A. O. SCHAEFER[4]

It is an encouraging sign to see a prominent member of American industry willing to share the results of important investigations with others. The authors of this paper are correct in their belief that "a record of their company's investigations during this period would be of benefit to all those interested in large rotor forgings." Their statement may be extended. This record benefits all users and manufacturers of steel forgings.

The introduction of ultrasonic methods of inspection made possible far more thorough examination of masses of metal. The problem of correct technique for the conduct of the test is outweighed by the much more difficult problem of interpretation. It is because of this that industry should welcome the publication of experience and investigation such as this. We need much more of this sort of work to provide the basis of the agreement that must be reached between producer and consumer in this field.

The occurrence of thermal cracks in steel has been known and discussed for many years. The causes of thermal cracks and the means to prevent them are quite well known. Ultrasonic inspection provides a tool ideally suited for the detection of defects of this type. The problem is to distinguish them from other irregularities such as segregation, coarse grain, inclusions, etc.

Cracks of any sort, falling within the dimensions of a finished piece, are generally admitted to be cause for rejection. Thermal cracks are particularly insidious because they are always internal. Past methods of inspection revealed them only when they were laid bare by machining.

Special congratulations are due the authors of this paper not only for revealing the defects which caused the ultrasonic indications but also in evaluating the effects of the thermal cracks by further mechanical testing. Again, it may be pointed out that the possible harmful effects of thermal cracks may far exceed the actual effects. These will depend to a great extent on size and orientation.

The work that is presented in this paper is tremendously expensive both in time and money. The opportunity to do such work does not often present itself. We are particularly grateful to the authors of this paper for extending our

[1] General Superintendent, Chemical and Metallurgical Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

[2] "Thermal Cracks in Turbine and Generator Rotor Forgings," by A. W. Rankin, C. J. Boyle, C. D. Moriarty, and B. R. Seguin, MECHANICAL ENGINEERING, vol. 72, July, 1950, pp. 559–566.

[3] Assistant Metallurgical Engineer, Railroad Materials and Forgings, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

[4] Vice-President in charge of Engineering and Manufacturing, The Midvale Company, Nicetown, Phiadelphia, Pa.

field of information on a subject of great importance.

COMMENT BY J. C. SMACK[5]

The authors have done an excellent job of obtaining the complete story by tying in the oscillograms with cross sections of the actual defects, photomicrographs, and destructive tests.

I should like to present two questions which will probably clarify some points in the tests described.

1 It is assumed that all the tests were conducted at 1 megacycle with 1-in. crystals. Is this correct?

2 Have comparative tests been made at higher and lower frequencies since the Works Laboratory acquired standard instruments with four testing frequencies, and what were the results?

Frequently, it has been the practice of others when testing large forgings to depend upon a comparison of the indications at $^1/_2$ megacycle, 1 megacycle, and $2^1/_4$ megacycles to help identify the type of "defect." Some have even used 5 megacycles to obtain additional metallurgical information, the relative degree of sonic penetration being more evident at the higher frequency. Also, at the higher frequencies—$2^1/_4$ and 5 megacycles—there is less beam spread. The nearly straight beam of vibrations frequently will assist in the more accurate determination of the size and position of the reflecting medium.

A comparison of test results at any two frequencies will often provide a basis for determining the type of "defect," such as thermal cracks or nonmetallic inclusions. For example, a comparison of tests at 1 megacycle and $^1/_2$ megacycle would, it is believed, show a proportionately greater drop in size of indication from a nonmetallic inclusion when testing at $^1/_2$ megacycle, than would be noted from a thermal crack.

A few minor comments follow:

1 It has recently been found practical to test forgings over 25 ft long. Press columns 47 ft long have been tested successfully longitudinally.

2 Continuous movement of the searching unit is important but it is debatable whether more is gained by moving the work instead of moving the crystal.

3 Spring-mounted crystals are satisfactory and desirable for curved surfaces but not generally satisfactory for flat surfaces owing to possible tilting of the crystal, resulting in poor contact and nonuniform testing.

[5] Sales Engineer, Sperry Products, Inc., Danbury, Conn. Mem. ASME.

COMMENT BY A. P. SPOONER[6]

The writer would like to quote as follows from a paper presented by one of the authors, C. J. Boyle, 5 years ago:[7]

"There is a possibility that within the next few years supersonic or ultrasonic testing will be perfected to such an extent that it will be possible and practical to detect these hidden flaws before a number of expensive machining operations are performed."

The present paper is an excellent example of the progress that has been made in the inspection of large forgings since Mr. Boyle made his prediction. That practical methods of conducting this test were developed over a 4 or 5-year period is certainly noteworthy. What the next 5 years will bring forth is a matter of conjecture.

A group has been appointed by Subcommittee VI of Committee A-1 of the American Society for Testing Materials to prepare a procedure for the ultrasonic inspection of forgings. The report of this Committee, when available, and if approved and adopted, should be a step forward in standardizing the method or methods for conducting this inspection.

The statement that ultrasonic indication does not enable, in itself, differentiation between cracks and inclusions is fully appreciated by those who have applied this method of inspection to large forgings. In the present state of the development it is of paramount importance to recognize that ultrasonic inspection is a means of locating irregularities but does not differentiate between conditions which may be insignificant or those which may be harmful.

The various methods which the authors present as a means of exploring the irregularities which were located by ultrasonic testing are most interesting. The best method, of course, would be to test the whole part to destruction to study the effects of the various conditions which may be brought to light. In large parts such as under consideration this is naturally impractical. The next best method would be to test sections as large as practical under conditions as close as possible to operating conditions. The spin test reported in this paper provides an excellent example of this approach to the problem.

By such tests as the spin test on pieces of substantial size a survey can be made on the condition of the part. Such a survey, instead of exaggerating the effects of small local irregularities, brings them into their true light in relation to the part as a whole. If they are of little consequence their presence will be unnoticed; if serious, their occurrence will be associated definitely with the failure of a representative part.

This presentation which we consider to be fair, adequate, and tempered by sound judgment should be the means of promoting further thought and consideration of this important subject.

[6] Metallurgical Engineer, Bethlehem Steel Company, Bethlehem, Pa.

[7] "Magnetic Particle Inspection of Forgings," by C. J. Boyle, ASTM Symposium, Philadelphia, Pa., January 22, 1945.

COMMENT BY H. A. WAGNER[8]

Interpretation of the results of sonic testing, that is, the determination of whether a sonic discontinuity actually represents a flaw of sufficient magnitude and disposed in a way such as to be serious, has been one of the difficulties in using this testing procedure. While the present results indicate that much has been learned in interpreting ultrasonic indications, it would still appear to be a matter of judgment in many cases as to whether cracks indicated by ultrasonic means are of sufficient number and size and so located as to warrant rejection of the forging.

The writer would be interested to learn whether the chemistry of forgings used for rotors has been modified to reduce the incidence of thermal cracking. Very few inspection methods will detect flaws completely. A very real purpose will have been served, however, if modification of the chemistry, as a result of ultrasonic indications, has tended to reduce or eliminate thermal cracks. The alternative is to change forging practice so that if the cracks occur, they will be welded together during the forging operation. Have changes been made in the forging practice for these rotors to provide sounder forgings?

It has occurred to the writer that should a concentration of thermal cracks, nonmetallic inclusions, or other inhomogeneities occur in a turbine or generator rotor, this might contribute to the thermal instability of the shaft because of the stress concentrations occurring. By eliminating rotors where such concentrations occur, it would seem that less trouble might be experienced with thermal instability.

AUTHORS' CLOSURE

The authors are pleased that the results presented in their paper are regarded as of definite benefit in the production of sound forgings, and express their appreciation for the comments of the various

[8] Chief Mechanical Engineer, Mechanical Engineering Division, Engineering Department, The Detroit Edison Company, Detroit, Mich. Mem. ASME.

discussers. It is true, as stated by Mr. Schaefer, that investigations of this magnitude cannot be made very often because of the great expense involved in both time and money, and it was specifically for this reason that the authors' company believed that the results should be presented as completely as practicable.

The comments of the various forging manufacturers and users indicate that they too have been faced with the problem of deciding whether an ultrasonic indication is caused by a thermal crack requiring rejection of the forging or a nonmetallic inclusion of the type which are present to some degree in all forgings. We sincerely hope that the results presented in this paper will be of assistance in arriving at a correct decision since both manufacturers and users of large forgings are penalized if a defective forging is placed in a manufacturing schedule or if a sound forging containing only harmless nonmetallic inclusions is scrapped.

In reply to Mr. Price's questions concerning the effect of various frequencies on flaw reflections, this is an important consideration. The aim of this investigation was to disclose flaws of a size that might be harmful. Earlier investigations on gas-turbine rotors and other material, using frequencies ranging from $\frac{1}{2}$ to 10 megacycle, indicated that 1 megacycle would be a suitable frequency for testing steam-turbine rotors. We desired a frequency that would not be affected by normal variations in grain structure and yet reveal indications of discontinuities greater than $\frac{1}{8}$ in. in diameter.

Mr. Price's question as to why their tests at 1 megacycle do not reveal indications as high as ours is understandable since he has not had the opportunity of cross-checking the forgings referred to in the paper. In reference to Fig. 8 (*b*), it will be noted that the magnification is 500 diameters; magnetic particle testing of the sectioned rotor revealed that these inclusions covered a plane of about one inch in diameter.

In reply to Mr. Schaefer, we are also of the opinion that the general causes of thermal cracking and the means to prevent them are known. However, for reasons of more or less validity, thermal cracks are sometimes present in large forgings, and consequently the inspection system must be capable of detecting them without destroying the forging. In this sense the ultrasonic inspection is ideal. As just stated, the results of ultrasonic inspection must be interpreted with care to forestall the rejection of large forgings containing only nonmetallic inclusions. We have found that spin testing of full-size disks containing thermal cracks has been of assistance in furnishing an approximate quantitative evaluation of the degree to which such cracks can lower the bursting speed in simple rotation. Nevertheless, we can not accept rotors containing thermal cracks as the possible harmful effects can exceed the actual effects obtained in spin testing, as was stated by Mr. Schaefer.

In reply to Mr. Smack, we used 1 megacycle with 1-in. crystals throughout this investigation, and made no comparisons at different frequencies. As stated in reply to Mr. Price, we investigated various frequencies before starting the investigation on large rotor forgings, and since this paper was written we have made some checks with other frequencies and equipments. Theoretically the cross-checking of a given flaw indication by the use of various frequencies should supply extra information that may assist in determining the nature of the flaw, and such information should be obtained on questionable flaws for later correlation.

On the comment pertaining to the relative movement of crystals and the work, there is no difference in sensitivity but there is a considerable difference in ease of interpretation. If an object can be rotated about its axis of symmetry, reflections from symmetrical changes of contour remain frozen on the screen while flaws, which are rarely symmetrical, come in and out of the picture and are thereby readily discernible.

Test comparisons on spring-mounted crystals versus rigid-mounted crystals resulted in our modifying all our standard ultrasonic units to make them suitable for use with either type of crystal mounting.

We appreciate Mr. Spooner's reference to the work of Subcommittee VI of Committee A-1 of the American Society for Testing Materials in preparing a procedure for ultrasonic testing of large forgings. Ultrasonic inspection is so sensitive that standardization is necessary in both the methods of conducting the test and of interpreting the results. We hope that our paper will be of assistance to this Committee. We regard spin testing as of definite quantitative significance in evaluating the harmfulness of thermal cracking, but because of unknown factors in routine machine operation we do not believe that spin testing is a complete answer to such questions. We appreciate that Mr. Spooner is in agreement with our procedure of rejecting forgings which contain thermal cracks.

In reply to Mr. Wagner's questions as to whether we made a change in chemical composition to minimize the tendency of thermal cracking or a change in forging practice to provide for welding up of thermal cracks, no change was made in either the chemistry or forging practice. Metallurgical investigation of the cracks showed that they were transcrystalline in nature with no distortion, and this indicated that the cracking had taken place during the final phases of the heat-treating cycle. Any other suitable chemical composition would also tend to be subject to thermal cracking if the correct thermal practice were not used, and since the thermal cracking had taken place after the rotors had been forged to their final shapes, no change in forging practice was considered necessary. Our experiences prior to and after the era of our paper have shown us that forgings having our chemical composition can be made without thermal cracks if the correct thermal practice is used. We have not yet observed any correlation between instability in the heat-indication test and any concentration of inhomogeneous areas in the forging, although it would appear that such a concentration could adversely affect the thermal stability.

A. W. RANKIN.[9]
C. J. BOYLE.[10]
C. D. MORIARTY.[10]
B. R. SEGUIN.[10]

Special Production Machinery

COMMENT BY P. R. HOOPES[11]

This paper[12] is an excellent summary of the problems involved in the use of special production machinery. The writer's 35 years of experience in developing such machinery confirms nearly everything the author says. We differ, and that not too seriously, only on minor details of design procedure. These comments are, therefore, merely suggestive of an alternative approach to one or two such details.

Management should not expect satisfactory results with special machinery if development is undertaken as a sideline of the general plant engineering department, or if the machinery is built in the plant maintenance department.

[9] Steam Turbine and Generator Engineering Divisions, General Electric Company, Schenectady, N. Y. Mem. ASME.

[10] Schenectady Works, General Electric Company.

[11] Consulting Mechanical Engineer, Philadelphia, Pa.

[12] "Using Special Machinery to Increase Production," by C. A. Nichols, MECHANICAL ENGINEERING, vol. 72, April, 1950, pp. 289–294.

Perhaps the best results are obtained if the amount and variety of development work to be done justify employment of a full-time staff of experienced machine designers under a top-level engineering executive responsible solely for new equipment, but not involved in any way with the product, plant operation, or production. Such an organization can, and often does, produce remarkable results. If the machine-development department can be separated physically from the production plant, and can be provided with its own shop facilities, so much the better. Industry has long since recognized the difference between laboratories for scientific research and those for plant control. A similar point of view with respect to the difference between machine development and plant engineering would prove equally profitable.

Comparatively few industries can take advantage of a completely integrated machine-development department. The amount of work to be done is frequently too limited to justify continuous employment of first-rate development engineers. In such cases management can turn the problem over to an outside machine shop specializing in designing and building equipment to order, or to an independent engineering organization specializing in design only, with construction by a contact machine shop.

When the equipment to be developed is closely analogous to standard machinery, such as printing, package-wrapping, and wire-forming machinery or single-purpose machine tools, an outside shop, specializing in designing and building such standard machinery, often can undertake the development of a special machine in its field, with results which are both better and cheaper than can be secured in any other way.

When the machinery to be developed is of an unconventional type, such as multiple-operation automatic machines, equipment for handling unusual materials, and the more elaborate line mechanizations, an independent development organization sometimes can be used to advantage for designing and manicuring the machinery, construction being done on contract to the drawings by any properly equipped and staffed jobbing shop.

Regardless of the procedure adopted, however, it is important that final responsibility for the design should rest with the design engineer. Committee meetings of representatives of production, maintenance, quality control, and engineering are of the greatest value in setting up performance and operating characteristics of the proposed equipment, but the technical means by which the results are obtained, and the details of design, should be left with the design engineer. He will be less than competent if he fails to seek advice from the maintenance and production departments but, in general, the latter should act in an advisory capacity only and not as critics of the design. It is important, as the author has indicated in his paper, that the men who will be responsible for operation of special machinery be brought into the discussion before the design is completed, and that their active interest and approval be assured before installation. They should not, however, be expected to assume any responsibility for the design itself. Indeed, if they are asked to criticize the details of the design, there is a probability that the designer either will have to sacrifice sound principles to satisfy honest but technically uninformed criticism, or risk, offending the critic by ignoring his suggestions.

As the author so clearly points out, one of the most essential and time-consuming steps in development is the final manicuring. Much can be done to simplify and shorten this work if the designer keeps in mind that unless every detail functions perfectly on paper, a machine will never work satisfactorily in metal. This is only another way of saying that too much care cannot be taken in preparing the drawings. Short cuts on the drawing board, and especially the type of thinking which results in notes to the effect that a tool or part is to be "made to suit" or "developed at assembly" are sure to result in high manicuring costs. Timing, particularly of cam-operated machines, should be worked out fully by the design engineer and not left to "off the cuff" decisions in the shop. Experimental work of the "bread board" variety is sometimes advisable before starting a design if the nature of the material to be handled or the operations to be performed on it are unusual. There is, however, no excuse for experiments on mechanisms as such. With rare exceptions, all shopwork should be made to conform strictly to the drawings. Even when this involves scrapping incorrectly machined parts, the results, as well as the over-all cost, will be more favorable than if changes are made in a well-considered design.

A special machine which has been designed carefully on the basis of any necessary preliminary experiments, with complete detail drawings thoroughly checked, and construction in strict accordance with the drawings by a qualified shop, should go into operation without serious expense for manicuring. Manicuring is something of an art. It should, if possible, be under the direct personal supervision of the designer. Radical changes are rarely necessary, manicuring of a competently designed machine being usually a matter of clearances, tool shapes and the like, and the elimination of numerous small unforeseen defects of material and workmanship.

It has been the writer's experience that a special machine of the complicated, fully automatic type, costs about as much to design as it does to build the first machine, and that manicuring rarely exceeds 10 per cent of the combined cost of design and construction.

Training for Transition to Professional Responsibility

TO THE EDITOR:

One important objection may be taken to the views of William Oncken, Jr., on "Training for Transition to Professional Responsibility." (MECHANICAL ENGINEERING, August, 1950, pages 634-636, and 640). The objection has greater significance since he is director of training at the U. S. Naval Ordnance Laboratory.

He emphasizes that the junior mechanical engineer should have "ability to work in close harmony with the other persons in his immediate group." Further on, he says in connection with discussion meetings, "Most important, they should close with complete agreement, even if that agreement must be on points on which agreement cannot be reached within the time allotted."

Nowhere in the article has he said anything about the importance of freedom of expression and of development of new ideas. He has said nothing about the responsibility of the group to the individual who has an unusual or uncomfortable idea. No emphasis has been placed upon the training of the young engineer to seek new ideas or methods and argue for them in a courteous way until he has developed arguments convincing to him against them. Oncken's emphasis is on the conformity of the young engineer to the group. No wonder "We're Not the Best in the World."

Hanson W. Baldwin, a former naval officer and the military editor for *The York Times*, has written under the preceding title in the *Saturday Evening Post*, July 15, 1950, pages 29, 107, and 108. He claims our victories were the result of

mass production and greater man power and not because of military-development skill. He lists a series of naval weapons where our opponents were ahead of the United States, and our former associates still are ahead of us. He claims that if we are to win in another world war we need not only better quality in men, admirals, and generals, but also in weapons. That quality will not be obtained in naval weapons unless we train our young engineers in the importance of independent thinking. They need assurance they will be supported in such thinking in the Naval Ordnance Laboratory.

GREGORY M. DEXTER [13]

TO THE EDITOR:

Without, I am sure, intending to do so, Mr. Dexter seems to have selected from my article two quotes and read into them a meaning entirely foreign to the ideas I attempted to develop in my article on "Training for Transition to Professional Responsibility" which appeared in the August, 1950, issue of MECHANICAL ENGINEERING. Such a procedure would be necessary to suggest from my paper that:

(*a*) We at the Naval Ordnance Laboratory are blind to "the importance of freedom and expression and of development of new ideas" on the part of our younger scientists.

(*b*) We have no "responsibility . . . to the individual who has an unusual or uncomfortable idea."

(*c*) These two attitudes contribute to the delinquency of our nation as expressed in Hanson Baldwin's article "We're Not The Best in the World," appearing recently in the *Saturday Evening Post*.

In reply, I should like to quote the immediate contexts of his two quotations. "Ability to work in close harmony with the other persons in his immediate group" should be read together with "Ability to design *creatively* and *inventively*." The other passage, "Most important, they should close with complete agreement etc.," should be read together with the immediately preceding sentence: "To be successful such meetings must display full participation. They must get consideration for *all relevant opinions, viewpoints*, and *experiences*, etc." I am surprised that any responsible engineer could have overlooked so obvious a context.

WILLIAM ONCKEN, JR. [14]

[13] Consulting Engineer, Scarsdale, N. Y. Mem. ASME.

[14] Director of Training, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Marine Gas Turbines

COMMENT BY F. T. HAGUE [15]

The Gas Turbine Power Division is grateful to the author for his consideration in presenting an outline of the broad scope on which the marine application of the gas-turbine plant is being studied in England.[16]

The seven units built and building would appear to indicate a conviction on the part of the Admiralty and others that the present-day potentialities of the marine gas turbine are sufficiently attractive to warrant building prototypes for gunboats, frigates, coastal craft, tankers, and merchant ships, covering the range of short, medium, and long-life applications.

The paper is stimulating because it reflects a basic confidence which the British have in the future of the gas turbine. Whittle's jet engine was a "first" which stimulated gas-turbine research and development everywhere. The revolution which has occurred in military aviation in the past 5 years, due to the introduction of the jet-engine power plant, has had a profound inflationary influence on executive opinions as to its possibilities of conferring similar blessings when applied to marine and industrial applications. Like some other developments "glamourized" during the war, the marine gas turbine was a disappointment because it did not develop expected Utopian properties. Extremes of optimism and pessimism have a habit of being cyclical in character in the United States, and at this time the application possibilities of the marine gas turbine are being re-evaluated on their basic merit, and a resumption of interest is to be expected.

The methodical and sustained approach to developing the present and future possibilities of the marine gas turbine in England must command respect. Ample evidence is submitted that present-day prototypes have technological merit and need only extended practical experience to fit them for use in many classes of ships.

Informed opinion is generally in agreement that the realization of the speculative gains of the future are mostly dependent upon the development of practical means of liquid cooling. Government and industry-sponsored research are intrigued by this unique possibility of the gas turbine. It is not over-optimism for research workers to look far ahead, nor should it be disturbing to practical people to learn that researches of this type are under way. After all, the limits to efficiency in power generation will not always be set by the present conventional types of engines, and the research engineer should be privileged to do some dreaming.

COMMENT BY P. H. MARTINUZZI [17]

The list of British organizations dealing with gas turbines quoted by the author shows that there is some degree of co-ordination in gas-turbine work in Britain. Personal observation has shown that this co-ordination actually exists, although not to the extent that might be inferred from publications, but in any case to a much higher degree than is prevalent in the United States. This might well be one of the causes of the rapid progress of the gas turbine in Britain.

It would be interesting to know the author's opinion as to whether a life of 100,000 hr at full power is really a justifiable requirement. It might well prove expedient to make at least part of the machines expendable after a much shorter period, say, 10,000, hr. This applies particularly to parts subjected to high temperatures. In a period of very rapid progress in metallurgy, the solution would have the advantage that renewal parts would incorporate all the latest progress. The temperature of 2200 F, quoted by the author as an aim for the future in conjunction with some form of blade-cooling, corresponds very closely to similar predictions made by other prominent gas-turbine experts. There is little doubt that these temperatures will come into general use in industrial gas turbines. The question is when. Opinions differ on this point; periods as short as 5 years and as long as 20 have been quoted. The author's point of view would be greatly appreciated. Also, what temperature would the author use for a long-life marine turbine to be designed and built now?

It would be most interesting to have further details on the regenerative type of heat exchanger. When will it be available? What saving in weight and volume can be achieved over a recuperator giving the same efficiency? On paper it would appear that, if materials capable of absorbing and releasing heat very rapidly

[15] Consulting Engineer, Westinghouse Electric Corporation, Philadelphia, Pa. Mem. ASME.

[16] "Marine Gas-Turbine Research in Britain," by T. W. F. Brown, MECHANICAL ENGINEERING, vol. 72, May, 1950, pp. 379–388.

[17] Professor of Mechanical Engineering, College of Engineering, Cornell University, Ithaca, N. Y.

can be developed, the regenerative heat exchanger would show tremendous advantages.

The author's opinion and experience with radial inflow turbines would be welcome.

As regards the marine gas turbine, there is no doubt that a suitable type of reverse gear is indispensable; the use of reverse turbines would complicate the design too much. What is the author's opinion on reversible-pitch propellers? Kaplan hydraulic turbines, which are in effect variable-pitch propellers, have proved most reliable even for very large powers.

With all the talk there is about atomic propulsion for ships, has the author considered the use of gas turbines in conjunction with this? An atomic reactor is a power generator giving almost ideal fuel consumption, but having a very considerable specific weight. Under these conditions, it would seem logical to use atomic power for cruising and very lightweight short-life gas turbines for combat. And, of course, some form of closed-cycle gas turbine probably will be used to convert the reactor's heat into power.

COMMENT BY IVAN MONK[18]

The author has given us a complete portrayal of the present status and probable future of the marine gas turbine. The excellence of his paper is further enhanced by the fact that he has not neglected the possibilities of further developing other types of marine power plants.

An important part of the development of any type of marine machinery is summarized in the statement "Try it on the test bed until it is considered proper to install it in a ship." Admittedly, this is expensive and time-consuming. In the past we have tried to get around it by adopting conservative designs or by using the tests of small-sized models as bases for designing full-sized propulsion machinery to be installed directly in a ship. Recently the writer discovered in one of the author's papers a significant observation concerning model testing. He stated that after extensive experience in testing marine machinery, he was convinced the best scale to use was 12 in., 1 ft.

The U. S. Navy is making progressively greater use of full-scale machinery tests prior to developing designs for mass production. As one example, we have operated many large propulsion gears under overload conditions at the Naval Boiler and Turbine Laboratory, and their performance simply could not have been predicted by conventional theory. It has been difficult enough merely to correlate test results with theoretical performance. While successful laboratory tests do not guarantee the same performance in a ship, we may safely assume that deficiencies which come to light in the laboratory would also assert themselves under shipboard operating conditions.

The author quite properly has included in his paper a discussion of maneuvering and transmission systems. The ultimate success of the marine gas turbine will be influenced greatly by the characteristics of the systems available for coupling the turbine to the propeller. Fig. 10 of the paper indicates very impressively the inherent advantages of epicyclic reverse and reduction gearing, as compared with more conventional types. Unfortunately, the former has not been developed to the point where a reliable 10,000-hp unit is commercially available. One of the major problems associated with this type of unit is the difficulty of getting rid of the large amounts of heat generated at the braking elements while reversing the direction of propeller rotation. One possible solution to this problem might consist of utilizing hydraulic brakes for the initial braking period and friction brakes for final braking. This combination of hydraulic and friction brakes would permit the desirable heat-absorbing features of the hydraulic drive to be combined with the more efficient and compact epicyclic-gear drive.

It is probable that much development work would be required to obtain a large epicyclic-gear drive suitable for marine use. However, its advantages of light weight, compactness, and high efficiency make it so attractive that its development should be prosecuted vigorously, concurrently with the development of the marine gas turbine.

COMMENT BY R. TOM SAWYER[19]

Will the author explain why a temperature of 2200 F was selected for the future gas-turbine plant?

A future steam plant and a future gas-turbine plant are listed in the paper, but as no future Diesel plant is listed, does the author assume that the Diesel engine is going to stand still?

It is assumed that the future Diesel plant would have a fuel consumption even better than the future gas-turbine plant shown. However, does not the author consider the thermal efficiency of the gas turbine a secondary factor compared to the Diesel in that the cost of fuel would no doubt be less for the gas-turbine plant than the Diesel?

AUTHOR'S CLOSURE

Mr. Hague's contribution to my paper is characterized by sound and well-balanced judgment and the author is particularly pleased to be able to say that the paper owes much to Mr. Hague's encouragement to state clearly what are the possibilities of the marine gas turbine from the British viewpoint. The author is very pleased to have Mr. Hague's endorsement that the realization of the gains to be achieved by the use of gas-turbine-propulsion sets at sea will be intimately tied in with the use of high gas temperatures, this use being conditional upon the development of practical means of liquid cooling.

The author is glad to know that Professor Martinuzzi has realized that there is co ordination in gas-turbine work in Britain. Some of this co-ordination may not be very clearly defined, but it is certainly understood in Britain that the only way to obtain reasonable progress for the benefit of all is by exchange of information and the serious prosecution of research.

The question of life and the repair by replacement of marine machinery has been discussed on many occasions. In the case, however, of parts subjected to high temperature which may require replacement, only small parts which can be replaced in a short period of time should be designed to be expendable. For merchant ships, however, their ordinary service is so little known that an attempt should be made to design machinery which has a suitable margin for further running even when the machinery is due for survey, and it should not be necessary to carry out surveys at more frequent intervals than those already applicable to steam-turbine plant. The idea in merchant ships of replacing, say, a high-pressure turbine rotor with a short life as readily as a disk on a gramophone is not an attractive one.

If a long-life marine turbine has to be built now, the development work on liquid or other cooling is not sufficient to enable confidence in incorporating this directly in the design at this stage and if a life of 100,000 hours is required now the maximum temperature would be 670 C.

Professor Martinuzzi's queries about the weight and volume of a regenerative type of heat exchanger are answered in Fig. 7 of the paper.

Radial inflow turbines are ideal where large volumes have to be handled at

[18] Commander, USN, Turbines and Gears Branch, Bureau of Ships, Navy Department, Washington, D. C.

[19] Manager, Research Department, American Locomotive Company, New York, N. Y. Mem. ASME.

fairly low pressure ratios, but it should be understood that experience clearly shows that the turbine efficiency will be lower than that of the more conventional axial-flow type.

Reversible-pitch propellers do represent one of the solutions to the maneuvering problem but the mechanism inside the propeller is usually complicated and the efficiencies tend to be rather lower than those where the boss diameter can be smaller when it does not house such mechanism.

The author refuses to consider atomic propulsion for ships until the reactor has been further developed when, of course, the gas turbine is the logical type of machinery to develop power from the heat generated in the reactor.

Commander Monk's remarks are very much appreciated and the author endorses strongly Commander Monk's advocacy of full-scale tests on shore, as in the end both money and time are saved in comparison with the trouble which may occur when the machinery is installed and a complete ship has to be withdrawn from service to enable faults to be corrected.

Commander Monk's work in connection with the full-load testing of gearing is well known and his statement that deficiencies which come to light in the laboratory would also assert themselves under shipboard operating conditions is one to be read by those who are responsible for sponsoring new developments.

Epicyclic gears because of their inherent advantages will be developed even for merchant-ship propulsion. Commander Monk puts his finger on one of the difficulties to be surmounted and is extremely helpful in indicating a valid solution to the problem of removing the heat generated in the reversing gear while reversing the direction of propeller rotation. At such times the energy in the line shafting and propeller has to be absorbed within a short space of time without overheating the friction-brake element.

In connection with the comments by Mr. R. T. Sawyer, the author arrived at a temperature of 2200 F for the future gas-turbine plant as a result of an investigation given to The Institution of Mechanical Engineers and issued in their Transactions in September, 1950.

In connection with the query about future Diesel plant, the author feels that its future is so closely tied in with the gas turbine that only a combination system will emerge in which either the Diesel engine provides gas for a turbine which delivers the power to the shaft, or a gas turbine operating at very high supercharge provides smaller dimensions to a Diesel engine for any given power. The future Diesel plant cannot have a fuel consumption better than at present unless higher temperatures can be utilized, which does not seem to be probable. The difficulty of deciding what fuel can be utilized by a gas turbine has still to be solved and some of the factors involved in the research in fuels are given in the author's paper. T. W. F. BROWN.[20]

[20] Research Director, The Parsons & Marine Engineering Turbine Research & Development Association, Pametrada Research Station Wallsend-on-Tyne, England.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Materials Engineering of Metal Products

MATERIALS ENGINEERING OF METAL PRODUCTS. By Norman E. Woldman. Reinhold Publishing Corporation, New York, N. Y., 1949. Cloth, 6 × 9 in., 149 tables, 169 figures, references, Appendix, Subject Index, and 583 pp., $10.

REVIEWED BY J. F. YOUNG[1]

THIS book has been written as a companion to "Metal Process Engineering" by the same author. The new volume is intended for engineering students, professional engineers, and production engineers.

The author has used a novel approach in his preparation of this work in that the information is correlated and interpreted in terms of four major product groupings. These are: (1) Lightweight constructions involving aluminum, magnesium, the high-strength low-alloy steels, and the stainless steels. (2) Mechanical products such as gears, springs, bearings, and fasteners. (3) Electrical-industries materials such as magnetically soft and hard alloys, electrical contacts, thermostat metals, and electric-resistance alloys. (4) Special-service materials for corrosion-resistant and high temperature applications.

A final chapter covers a brief review of mechanical property testing and nondestructive testing.

The text is amply illustrated with 169 illustrations of typical equipment and applications. In addition 149 tables of property values and property relationships are included in the text, together with an appendix of 47 pages covering specifications and mechanical properties of commercial alloys and some information on plastics, refractories, and ceramics.

It is believed the author has made a very worth-while contribution that will prove particularly valuable to practicing designing engineers and production engineers. The typical design problem of selecting a material for a given product application requires review and evaluation of many potential materials. To have the typical materials correlated by product, as the author has done, should prove a distinct advantage to the engineer faced with a product selection or application problem.

The advantage to the student is perhaps less since the assimilation of so vast a subject should be accomplished more expeditiously through a presentation of classical fundamental type. The author does not indicate the college level for which the new volume is intended but, if utilized as a text, it is believed it would be best suited as a companion to machine-design courses and after classical presentation of metals by types.

A possible shortcoming of the text from the standpoint of engineering training is its limitation to the metal-products fields just outlined. The absence of information on nonmetallic materials in fields of plastics molded parts, electrical insulations, rubber components, ceramic materials, and other materials might prove to be a disadvantage in college curricula if these additional subjects

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could not be provided in some other fashion.

Another limitation of the text to some users is the small amount of information and discussion of structural steels, compositions utilized in forgings, tools and castings, and material properties obtainable in heavy sections.

Although these points may prove limiting for some users, the author has made a much-needed contribution to the technical literature on materials engineering. His work is written concisely and clearly, and should prove of considerable reference value in the fields to which it applies.

Aircraft Structures

AIRCRAFT STRUCTURES. By David J. Peery. McGraw Hill Book Co., Inc., New York, N. Y., 1950. Cloth, 6 × 9 in., figures, tables, problems, references, appendix, index, vii and 566 pp., $6.50.

REVIEWED BY M. M. FROCHT[2]

IN A book of 566 pages comprising 18 chapters, an appendix, and index, Prof. David J. Peery treats the fundamental principles of aircraft structures.

Dr. Peery has taught engineering mechanics for some years and the influence of this experience is felt throughout the book. The author believes, "that most of the serious mistakes by college students and practicing engineers result from errors in applying the simple equations of statics." He therefore places heavy emphasis "on the application of the elementary principles of mechanics to the analysis of aircraft structures."

A large part of the book is devoted to a review of the basic concepts of statics, dynamics, and strength of materials with particular applications to aircraft structures.

The unique and commendable aspect of this book lies in the manner in which the seemingly involved new problems are reduced to familiar basic concepts of mechanics.

Chapters 8 through 15 contain specialized material on aircraft structures. Here we find chapters on aircraft loads and materials as well as on design procedures.

The chapter titles are at times misleading. For example, chapter 6, entitled "Shear and Bending Stresses in Symmetrical Beams" is devoted essentially to a discussion of shear flow and center of shear in aircraft structures.

The book is well organized, clearly written, and contains a large number of numerical examples. An abundance of simple, clear figures contributes materially to the clarification of the subject.

The only major criticism this reviewer would make refers to the treatment, or rather the lack of treatment, of fatigue and of stress concentrations which are disposed of with a few sketchy sentences. The author takes refuge in the usual shelter of "ductility." This, however, is insufficient at a time when the trend in the aircraft industry is for materials and methods of analysis which bring the significance of stress concentrations into the foreground.

This book deserves serious consideration as a text for courses in aircraft structures.

[2] Research Professor of Mechanics, Illinois Institute of Technology, Chicago, Ill. Mem. ASME.

Small-Plant Management

SMALL-PLANT MANAGEMENT: A Guide to Practical, Know-How Management. A Small Plant Committee Research Study Prepared Under the Auspices of the Management Division of The American Society of Mechanical Engineers. Edited by Edward H. Hempel, chairman, Small Plant Committee, ASME. McGraw-Hill Book Company, New York, N. Y., 1950. Cloth, 6 × 9 in., 348 pp., $6; $4.80 for members of the ASME, if purchased from the Society.

REVIEWED BY LILLIAN M. GILBRETH[3]

THIS is a book for which many of us have been waiting. The problems of small-plant management are vital to this country, as to all civilized countries, especially at this time, when production again becomes the problem of paramount importance.

The Management Division of ASME is proud that its Small Plant Management Committee, under the able chairmanship of Dr. Edward H. Hempel, has devoted itself to preparing what is essentially a handbook, covering many aspects of this most challenging subject.

The plan of the book is interesting. Appropriate authorities in the field have participated in the project and have written the various chapters. Wisely, there has been no attempt to restrict them in the way in which they handled their material. This has necessarily resulted in some duplication, but has proved to be interesting, as it gives the reader an opportunity to compare points of view and emphases.

It is likely that all readers will not agree with what is said by some of the writers about scientific management and the believers in know-how and the relationship between the two. This can only lead to valuable discussion and perhaps a reappraisal which should have good results.

The book requires careful, at times studious, reading. But the variety in subject, authorship, and style makes this pleasant as well as profitable. There is humor and often shrewd evaluations of principles, techniques, and problems that are highly quotable.

While the book does not and could not cover all the problems of human relations and technical procedure involved in this large field, there is the careful gathering of practice and the reasons for what is being done, that the manager of a small plant needs. He will find the book not only of great use, on first reading, but will use it as a reference, day by day, as he needs answers to questions that come to him. And all who are working in the management field will find real stimulus and benefit from the material, the way in which it is handled, and the provocative, sometimes controversial, ideas included. A list of the subjects of the chapters and their authors makes this clear.

Part 1, Small Plants as Economic Factors—The Economic and Industrial Importance of Small Plants, by A. D. H. Kaplan; Small Plant Financing and Banking, Everett D. Reese; Community Progress Created by Small Plants, Roy J. Colvert; Government Interest in Small Plants, Charles F. Hughitt.

Part 2, Management Tasks—Top-Management Planning for Small Plants, by Edward H. Hempel; Organizing the Small Plant, James D. Mooney; Operating the Small Plant, Adolf Ehbrecht; Supervising and Controlling the Small Plant, T. Alfred Marshall.

Part 3, How to Solve the Important Problems—How to Fulfill the Legal Requirements, by J. Raymond Tiffany and Benjamin Werne; How to Get Best Workers and Labor Relations, A. R. Meredith; How to Get Along With the Union, William Gomberg; How to Buy Best Facilities and Material, Henry T. Coates; How to Obtain Best Productivity, Parker Capps; How to Do Technical Research, F. W. Miller; How to Get Best Sales, Alfred B. De Passe; How to Do and Use Accounting, Clinton W. Bennett; How to Pay and Save in Taxes, Eugene J. Donahue; How to Make Savings and Use Profits, James B. Murray.

Part 4, Small Plant Future—The General Outlook for Small Plants in the United States, by R. Harland Shaw; Small Plant Opportunities in Latin-America and Other Countries, Joseph J. Maguru.

As one tries to list the people or groups who should find it interesting and useful—managers, teachers, consultants, econo-

[3] President, Gilbreth, Inc., Montclair, N. J. Fellow ASME.

mists, and so on—it becomes evident that it has a value beyond that which its title indicates, and should be a part of the library of everyone interested in management.

Books Received in Library

ASM REVIEW OF METAL LITERATURE, Vol. 6, 1949. Edited by M. R. Hyslop. American Society for Metals, Cleveland, Ohio, 1950. Cloth, $6^1/_4 \times 9^1/_4$ in., 953 pp., $15. As in the preceding volumes of this highly useful series, an annotated bibliography is provided of articles and technical papers appearing in a wide range of engineering, scientific, and industrial journals, both domestic and foreign. The whole metal-processing field is covered from ore beneficiation to metal fabrication. The main arrangement is by broad classifications with detailed subject and author indexes. Each volume is a compilation of the monthly installments in the ASM publication, *Metals Review*.

ASTM BOOK OF STANDARDS 1949, including Tentatives. Part 1, Ferrous Metals, 1400 pp., $10. Part 2, Nonferrous Metals, 1170 pp., $8. Part 3, Cement, Concrete, Ceramics, Thermal Insulation, Road and Waterproofing Materials, Soils; 1370 pp.; $8. Part 4, Paint, Naval Stores, Wood, Adhesives, Shipping Containers, Paper; 1320 pp., $8. Part 5, Textiles, Soap, Fuels, Petroleum, Aromatic Hydrocarbons, Water; 1730 pp, $10. Part 6, Electrical Insulation, Plastics, Rubber; 1410 pp.; $10. American Society for Testing Materials, Philadelphia, Pa., 1949–1950. Cloth, 6 × $9^1/_4$ in., illus., diagrams, charts, tables, $54 complete set of all six parts. Now covering more than 1550 specifications, tests, and so on, this new combined edition contains all of the standards, adopted and tentative, as of the present date. In order to accommodate the increased number of items, the present edition is in six volumes instead of five. Each volume is complete with detailed subject index, both classified and numerical lists of standards, and arranged to provide technologists and others with as usable a book as possible.

ASTM STANDARDS ON RUBBER PRODUCTS, prepared by ASTM Committee D-11 on Rubber Products, April, 1950. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 652 pp., illus., diagrams, charts, tables, $4.75. Over 100 standard and tentative test methods and specifications have been brought together in this book for reference and laboratory use. The methods cover chemical, physical, electrical, aging and weathering, processibility, and low-temperature tests on rubber. Materials considered include automotive and aeronautical rubber, hose and belting, rubber coatings, latex foam and sponge, cements, and electrical insulating and protective equipment. Both a classified and a numerical index are provided.

APPLIED MECHANICS DYNAMICS. By G. W. Housner and D. E. Hudson. D. Van Nostrand Co., Inc., New York, N. Y.; London, England; Toronto, Canada, 1950. Fabrikoid, 6 × $9^1/_4$ in., 295 pp., diagrams, charts, tables, $4.50. Prepared for use by junior engineering students, the text serves as a logical transition from the elements of dynamics, as studied in general physics, to the more advanced courses. The main emphasis is on method and the development of fundamental principles with applications to problems drawn of various engineering fields. The first part consists of a concise treatment of the dynamics of a particle. The remainder presents applications of the same methods to systems of particles and rigid bodies.

BACKGROUNDS OF POWER, the Human Story of Mass Production. By R. Burlingame. Charles Scribner's Sons, New York, N. Y., and London, England, 1949. Cloth, $6^1/_4 \times 9^1/_2$ in., 372 pp., tables, $5. The process of production by automatic machinery has had a steadily accelerating development. The author traces this development from its origins to its present highly important position, covering techniques, materials, and basic philosophies. The story is told in human and social terms with emphasis on the effect of mass production on the individual and on civilization as a whole.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. By A. L. Dyke. Twenty-second edition. Goodheart-Willcox Company, Chicago, Ill., 1950. Cloth, $6^1/_2 \times 9^3/_4$ in., 1244 pp. plus Addenda Sections 1–4, 120 pp., illus., diagrams, charts tables, $7.50. A remarkably comprehensive collection of information on automobiles and internal-combustion engines is presented in this manual for the use of students, repairmen, and owners. Topics covered include the principles, description, and operation of all mechanical, propulsive and electrical parts of an automobile, maintenance, testing and repair, specifications, and definitions. The more than 100 pages of new and revised material contain 1949 specifications on a wide variety of items, and information on vacuum spark control, ignition distributors, dynaflow, and so on. A wealth of illustrations and a detailed 90-page index increase the utility of the book.

Einführung in die TECHNISCHE THERMODYNAMIK. By E. Schmidt. Fourth edition, revised and enlarged. Springer-Verlag, Berlin, Göttingen, and Heidelberg, Germany, 1950. Cloth, $6^1/_4 \times 9^1/_4$ in., 520 pp., illus., diagrams, charts, tables, 30 Dm. Based on lectures given at the Technische Hochschule in Danzig, this book serves as an introduction to technical thermodynamics. This fourth edition includes many changes and revisions. Special attention is given to theoretical aspects, particularly to the second law of thermodynamics. Equipment based on heat-flow principles and heat radiation are also discussed and the most important relations of gas dynamics are derived. A short treatment of chemical thermodynamics is also included with special emphasis on combustion processes.

FASTENERS DATA BOOK. Published by Industrial Fasteners Institute, Cleveland, Ohio, 1950. Cloth, $8^1/_2 \times 11$ in., 208 pp., illus., diagrams, charts, tables, $3.75. This compilation of data on the engineering and application of industrial fasteners—bolts, nuts, rivets, screws, and special headed and threaded products—has been selected and reprinted from issues of the publication, *Fasteners*. The articles bear directly upon the design and use of fasteners and include the results of special experience, research projects, and so on.

FLOW MEASUREMENT AND METERS. By A. Linford. E. & F. N. Spon Ltd., London, England, 1949. Cloth, $5^3/_4 \times 9$ in., 336 pp., diagrams, charts, tables, 30s. This book provides a general survey of the art of metering the flow of fluids through both closed and open conduits. It discusses various types of meters, the basic principles of their operation, their limitations, installation, and maintenance. Although practical in nature, some theoretical material is included on flow formulas and their applications. A classified list of references dealing with various hydraulic measuring devices is also included.

GASTURBINEN MIT GLEICHDRUCKVERBRENNUNG. By R. Friedrich. Verlag G. Braun, Karlsruhe, Germany, 1949. Cardboard and linen, $5^3/_4 \times 8^1/_4$ in., 139 pp., illus., diagrams, charts, tables; linen, 10.80 Dm; cardboard, 8.80 Dm. This book considers the fundamentals, applications, and current state of heat engines. It treats the gas turbine both as a machine for power production and as a prime mover. Thermodynamic principles are developed in detail. The principal structural parts and questions pertaining to materials and fuels are comprehensively dealt with. Characteristic values of various gas turbines are also given.

HANDBOOK ON DESIGNING FOR QUANTITY PRODUCTION. By H. Chase. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1950. Cloth, 6 × $9^1/_4$ in., 564 pp., illus., diagrams, charts, tables, $7.50. The design of articles which are to be made in large quantities and partly or wholly of metals or plastics must be predicated upon the use of high-production processes: stamping, sand casting, die casting, screw machine, die forging, plastic molding, and so on. In this book the first part consists of chapters on design for quantity production by these various processes, each written by an authority. In the second part, these major methods are compared for various types of products to determine respective efficiencies.

HANDBUCH DER ROHRLEITUNGEN. By F. Schwedler and H. von Jürgensonn. Fourth edition. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Cloth, $6^1/_4 \times 9^1/_2$ in., 293 pp., illus., diagrams, charts, tables, 36 Dm. This handbook on pipe lines contains general descriptions of pipe lines for various applications, methods of calculation for pressure losses, heat losses and strength, descriptions of materials, and pipe-line standards. This fourth edition contains a short section devoted to developments throughout the world with particular emphasis on advances made in the United States. A bibliography is included.

HANDBOOK OF EXPERIMENTAL STRESS ANALYSIS. Edited by M. Hetényi. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1950. Fabrikoid, 1077 pp., illus., diagrams, charts, tables, $15. This comprehensive reference book, written by thirty-one authorities in the field, contains all the major experimental procedures that are being used in the investigation of mechanical strength. The methods included range from mechanical gages to x-ray analysis.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Topics of interest, such as residual stresses, interpretation of service fractures, and analogies are also included. In the appendix three theoretical subjects—theory of elasticity, dimensional analysis, and precision of measurements—are treated. Brief annotations are given to the references which are found at the end of each chapter.

INTERNAL BALLISTICS OF SOLID-FUEL ROCKETS, Military Rockets Using Dry-processed Double-base Propellant as Fuel. By R. N. Wimpress. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1950. Cloth, 6 × 9¼ in., 214 pp., illus., diagrams, charts, tables, $4.50. This book is concerned primarily with the utilization of solventless-processes double-base smokeless powder in artillery rockets of relatively short burning time. Including a considerable amount of previously unpublished information, it contributes substantially to the extension of the theory of rocket-motor performance. Other problems associated with rocket-motor design, such as ignition, nozzles, heating of motor walls, and test methods, are also considered, and pertinent experimental results are presented.

KOLBENVERDICHTER. By C. Bouché. Second edition, revised and enlarged. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Paper, 6 × 9 in., 160 pp., illus., diagrams, charts, tables, 12 Dm. In describing the characteristics of reciprocating compressors, particular emphasis is placed on, and a detailed presentation given to energy transfer and heat transfer in the compressor. The theoretical treatment is as brief as possible, and graphical solutions are generally used. P-V and T-S diagrams are used, and the results of research investigations are discussed.

KONSTRUKTIONSAUFGABEN FÜR DEN MASCHINENBAU. By W. Beinhoff. Springer-Verlag, Berlin, Göttingen and Heidelberg, Germany, 1950. Paper, 6 × 9¼ in., 184 pp., diagrams, charts, tables, 9.60 Dm. This book presents a variety of problems encountered in the design of machines including numerous structural problems progressing from very basic designs to complicated structures. Correct solutions to most of the problems are included.

MACHINING—THEORY AND PRACTICE. By H. Ernst and others. American Society for Metals, Cleveland, Ohio, 1950. Cloth, 6 × 9¼ in., 504 pp., illus., diagrams, charts, tables, $6.50. This book contains thirteen lectures by authorities on various theoretical and practical aspects of machining. Metal-cutting research, cutting-fluid theory, machinability, the macrostructure of metals, tool steels, cemented-carbide tool materials, tool-life testing, grinding, and the economics of machining are among the topics covered.

MANPOWER ECONOMICS AND LABOR PROBLEMS. By D. Yoder. Third edition. McGraw-Hill Book Co., New York, N. Y.; Toronto, Ont., Can.; London, England, 1950. Cloth, 6 × 9¼ in., 661 pp., diagrams, charts, tables, maps, $5. This book deals with the human resources of modern society and the problems which arise in the employment of man power. It considers man-power goals, historic patterns of man-power conservation, industrial unrest, wages, job markets, employment conditions, collective bargaining, policies and practices of labor organizations, and constructive industrial relations. Exercises and questions follow each chapter.

MATRIZEN. By R. Zurmühl. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Cloth, 6¼ × 9¼ in., 427 pp., diagrams, charts, tables, 25.50 Dm. Designed particularly for engineers, this mathematics text provides effective coverage of matrix calculations. The several chapters deal with the basic transformations, rank and linear dependence, bilinear and quadratic forms, eigenvalue problems, matrix structure, numerical processes for equation solution; and the application of matrix calculations to electrochemistry, vibration problems, adjustment of errors, and other technical fields.

MODERN PLASTICS ENCYCLOPEDIA AND ENGINEER'S HANDBOOK 1950. Published by Plastics Catalogue Corporation (Breskin Publications), New York, N. Y. Cloth, 8½ × 11½ in., 1212 pp., illus., diagram, charts, tables, $3. The Engineering Section of this extensive compilation, considerably expanded in the new edition, has four parts as follows: molding-design factors; molding, extruding, and casting; fabricating and finishing; machinery. Important commercial types of plastics are covered in separate chapters in the Materials Section, followed by information on film and sheeting, laminates and laminating. The Technical Data Section contains a group of annually revised charts, including the comprehensive Plastics Properties Chart, standard specifications, statistics, and bibliographies. There is a Directory Section with classified and indexed lists of manufacturers of plastics and equipment.

NATIONAL TRANSPORTATION POLICY. By C. L. Dearing and W. Owen. Brookings Institution, Washington, D. C., 1949. Linen, 6¼ × 9¼ in., 459 pps., diagram, charts, tables, $4. This book, based in part on a study of federal transportation activities made at the request of the Hoover Commission, analyses the American transportation system with emphasis on basic issues of public policy rather than on details of administration. It points out the defects in federal action, sets forth a program of needed policy revision, and recommends reorganization of federal government machinery designed to produce a more efficient transport system.

PETROLEUM AND ITS PRODUCTS (Twenty-fourth Annual Priestley Lectures). By W. J. Sweeney. The Pennsylvania State College, Department of Chemistry, Phi Lambda Upsilon, State College, Pa., paged by chapters, 1950. Stiff paper, 9 × 10¾ in., loose-leaf binder, illus., diagrams, charts, tables, $2.25. The series of lectures contained in this publication cover a wide variety of related subjects. The broad chapter divisions are as follows: occurrence; production and resources of petroleum; composition and analysis of petroleum; refining of petroleum; chemical products from petroleum; and the utilization of petroleum products.

PHYSICS OF HIGH PRESSURE. By P. W. Bridgman. The Macmillan Company, New York, N. Y.; G. Bell and Sons, Ltd., London, England, 1949. Cloth, 5½ × 8¾ in., 445 pp., illus., diagrams, charts, tables, $5.50. A comprehensive survey is provided of the field of high pressure. In this new impression, the major change occurs in the discussion of the volume relations of the five alkali metals. In addition, a supplement is added which is devoted to work done since 1931, with special emphasis on the author's own contributions. A list of references follows each chapter, and 236 papers by Dr. Bridgman are listed in an appendix.

PROTECTIVE COATINGS FOR METALS. By J. W. Gailer and E. J. Vaughan. Charles Griffin & Co., Ltd., London, England, 1950. Fabrikoid, 6¼ × 9 in., 261 pp., diagrams, tables, 24s. This book describes the most important of the various metallic and nonmetallic films or coatings which are applied for the protection of the more commonly used metals. It explains the theory of the action of each protectant and specifies in detail the methods of application. Emphasis is placed on a scientific choice of coatings for a particular environment. General aspects of inspection are considered in the appendixes. Summary tables provide data on the better-known coatings. A list of references is included.

RESISTANCE WELDING, Designing, Tooling and Applications. By W. A. Stanley. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Can.; London, England, 1950. Linen, 8¾ × 11¼ in., 329 pp., illus., diagrams, charts, tables, $7.50. The basic purpose of the book is to assist designing and manufacturing engineers in the development of their own ideas of how metal-made products may be more economically and efficiently produced. Equipment, materials used, design, tooling, and production techniques are all discussed. Material is included on spot welding, projection welding, seam welding and flash butt welding. The nearly 800 illustrations include a wide range of specialized fabrication procedures.

STATIONARY COMPRESSION IGNITION ENGINES. By C. H. Bradbury. E. & F. N. Spon, Ltd., London, England, 1950. Cloth, 5¾ × 9 in., 226 pp., illus., diagrams, charts, tables, 24s. Designed to fill the gap between the orthodox text on heat engines and the book which deals with design and general descriptive matter, this book covers combustion, fuel injection, supercharging, noise problems, vibration, and foundations. Maintenance and operation receive special consideration. Formulas and definitions are grouped in a separate chapter. Numerous plates, tables, diagrams, and a bibliography are included.

TABLES OF THE BESSEL FUNCTIONS OF THE FIRST KIND OF ORDERS SIXTY-FOUR THROUGH SEVENTY-EIGHT. (Annals of the Computation Laboratory of Harvard University, Volume 13). By the Staff of the Computation Laboratory, Harvard University Press, Cambridge, Mass., 1949. Cloth, 8 × 10¾ in., 566 pp., tables, $8. Continuing the Bessel functions tabulation which constitutes the bulk of this series of computation tables, the present volume provides, as usual, 10-place figures for the range specified. The methods employed in the computation and the means of interpolation within them are explained in the introductions to Volumes 3 and 4 of the series.

TABLES OF THE FUNCTION $\frac{\sin \phi}{\phi}$ AND OF ITS FIRST ELEVEN DERIVATIVES. (Annals of the Computation Laboratory of Harvard University, Volume 22.) By the Staff of the Computation Laboratory, Harvard University Press, Cambridge, Mass., 1949. Cloth, 8 × 10¾ in., 241 pp., diagrams, tables, $8. Fundamental in the analysis of a large variety of problems connected with the Fourier transforms of distribution functions, these tables find application in the fields of sound, statistics, optics, and antenna theory. Nine-place tables are given of the function, on a half-degree mesh, and with a range of ten revolutions. The full scope of the tabulation is extended to its first eleven derivatives.

TABLES OF THE GENERALIZED EXPONENTIAL-INTEGRAL FUNCTIONS. (Annals of the Computation Laboratory of Harvard University, Volume 21). By the Staff of the Computation Laboratory, Harvard University Press,

Cambridge, Mass., 1949. Cloth, 8 × 10¾ in., 416 pp., tables, $8. Used in antenna theory, like the previously tabulated generalized sine and cosine-integral functions, these functions provide solutions of the general wave equation in the case of a dissipative medium. They are tabulated to six decimal places, together with their differences in both directions. Computation and interpolation methods are explained in the introduction.

THEORETICAL HYDRODYNAMICS. By L. M. Milne-Thomson. Second edition. The Macmillan Company, New York, N. Y., 1950. Cloth, 6¼ × 9½ in., 600 pp., diagrams, charts, tables, $8.50 (60s, London, England). Based on lectures to junior members of the Royal Corps of Naval Constructors, this book provides a clear and methodical introductory exposition of the mathematical theory of fluid motion which will be useful in applications to both hydrodynamics and aerodynamics. Vector methods and notation and the complex variable are used. A knowledge of the elements of the infinitesimal calculus is assumed. Three important changes in this second edition are the introduction of the circle theorem, the theorem for the sphere, and the addition of a chapter on the flow of compressible fluids.

LES THÉORIES DE LA TURBULENCE. (Publications Scientifiques et Techniques du Ministère de l'Air, No. 237.) By L. Agostini and J. Bass. Au Service de Documentation et d'Information Technique de l'Aéronautique, Paris, 1950. Paper, 7 × 10½ in., 118 pp., illus., diagrams, charts, tables, 750 fr. In reviewing the important work in this field of the last twelve or fifteen years, this pamphlet devotes the first three chapters to general considerations on turbulence and the application of statistical mathematics to the analysis of turbulent motion. New physical theories of turbulence are dealt with in the remaining two chapters, including the similitude hypothesis. An appendix contains a number of experimentally determined curves which are applicable to the material presented in chapters 3, 4, and 5.

THERMODYNAMIQUE DE LA TURBINE A GAZ. (Actualités Scientifiques et Industrielles 1072.) By P. Chambadal, preface by C. Monteil. Hermann & Cie, Éditeurs, Paris, France, 1949. Paper, 6½ × 10 in., 315 pp., diagrams, charts, tables, 1700 fr. This book provides a systematic study of the operation of the gas turbine from the point of view of thermodynamics. Emphasis is placed on the several thermodynamic cycles under which these turbines can operate, with detailed analysis of each cycle. The use of combinations of gas turbines and Diesel engines or steam turbines is discussed as well as applications of the gas turbine.

VERÖFFENTLICHUNGEN ZUR ERFORSCHUNG DER DRUCKSTOSSPROBLEME IN WASSERKRAFTANLAGEN UND ROHRLEITUNGEN. Heft 1. By F. Tolke. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1949. Paper, 8 × 11 in., 137 pp., illus., diagrams, charts, tables, 24 Dm. This book is based on work done by the German Water Hammer Committee and contains six articles on the following subjects: the standardization of the general language and symbols, pertaining to water hammer; causes of water-hammer effects in the pressure pipe lines of water works; the failure of the Zasip pipe line; water hammer in single pipes; the quantitative determination of water-hammer effects in a power station; and the regulation of long hydraulic pipe lines.

WERKZEUG-HANDBUCH ÜBER SCHNEIDWERKZEUGE FUR DIE METALLBEARBEITUNG. By F. Pütz. Carl Hanser-Verlag, Munich, Germany, 1950. Cloth, 6 × 8 in., 418 pp., illus., diagrams, charts, tables, 34 Dm. This book is a guide for the purchaser of tools and an aid to the engineer and machinist in the correct selection of the proper tool for a specific application. It also discusses the characteristics, applications, and limitations of various types of drills, reamers, milling, cutting, threading, and other tools. The efficiency of various tool steels in the machining of different metals and alloys are also brought out. A section on the maintenance and care of tools is also included.

WISSENSCHAFTLICHE ABHANDLUNGEN DER DEUTSCHEN MATERIALPRÜFUNGSANSTALTEN, Folge 2, Heft. 7. HOLZSCHUTZMITTEL PRÜFUNG UND FORSCHUNG. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Paper, 8¼ × 11½ in., 132 pp., illus., diagrams, charts, tables, 21 Dm. This publication contains the results of many years of research on the development of testing procedures and the examination of wood-protection media by the German Materials Testing Laboratory. The nine papers in this issue are on the protection of wood from fungus growths, insecticides, tropical conditions, and seawater; the wettability of wood by wood-protecting media; wood protectors; the burning characteristics of protected wood; the effect of protectors on wood fibers; and the mutual effects of cement and wood-protecting materials. A bibliography is included.

ASME BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

As need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets []. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Unfired Pressure Vessels 1949

PAR. UA-20 Change formula (1) to read: $W_{mi} = H + H_p = 0.785\ G^2P + (2b \times 3.14\ GmP)$

Unfired Pressure Vessels 1950

PAR UW-50(f) Replace with the following:

(f) Vessels larger than 12 ft. in diameter which are to be pneumatically tested only, and which are not radiographically examined for the entire length of all butt-welded joints, shall be spot examined in the manner prescribed in Par. UW-52, prior to the application of the pressure test, preferably by radiography. All welds around openings and all attachment-welds, having a throat thickness greater than ¼ in., shall be inspected for their entire length for the detection of possible cracks, by the magnetic particle method, or alternatively by a penetrating colored or fluorescent oil method.

PAR. UW-52(b) Insert in second line after "waived":

except for vessels covered by Par. UW-50(f)

PAR. UA-47 Make formula (1) agree with the above corrected formula (1) of PAR. UA-20 under Unfired Pressure Vessels 1949 by including parentheses around:

(2b × 3.14 GmP).

PAR. UA-186(1) Revise as follows:

(1) All supports shall be designed to prevent excessive localized stresses due to temperature changes in the vessel OR DEFORMATIONS PRODUCED BY THE INTERNAL PRESSURE. Any arrangement of the structure which does not permit [radial] expansion and contraction of the shell will tend to weaken the vessel.

PAR. UA-186 Add the following as new paragraphs:

(3) Columns supporting field assembled vessels, and bearing loads which may produce high secondary stresses in the vessel wall should be so designed at the attachment to the wall, that no high stress concentration can occur near changes in shape, gusset plates if any, or at ends of attachment welds. It is preferable to use details permitting continuous welds extending completely around the periphery of the attachment, and to avoid intermittent or dead-end welds at which there may be local stress concentration. A thicker wall plate at the support may serve to reduce secondary stresses and, if desired, a complete ring of thicker wall plates may be installed.

(4) When superimposed forces on the vessel wall occurring at attachment for principal struts or gussets and supports of any kind can produce high bending stresses, and when thicker wall plates do not seem appropriate, an oval or circular reinforcing plate may be used. The attachment of such reinforcing plates should be designed to minimize flexing of the plate under forces normal to the surface of the vessel.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC to Study Engineering Man-Power Problem for NSRB

EFFECTIVE utilization of engineers in event of a large-scale mobilization is the objective of an 18-man Engineering Man-Power Commission created by the Engineers Joint Council at its regular meeting in the Engineering Societies Building, New York, N. Y., Sept. 13, 1950.

The action was the result of a letter from Robert L. Clark, director, Manpower Office, National Security Resources Board, asking the EJC "to get together outstanding individuals in the engineering field" to suggest policies and methods which would protect the nation from induction procedures of the last war which were responsible for so much waste of the skills of highly trained scientists and engineers.

The Commission is to be composed of three members from each of the EJC societies, American Society of Chemical Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the American Institute of Chemical Engineers, and three from the American Society for Engineering Education.

E. G. Bailey, Hon. Mem. and past-president ASME, was appointed temporary chairman of the Commission. Other members appointed are:

ASCE, George W. Burpee, Coverdale & Colpitts, New York, N. Y.; D. W. Winkelman, Pres., D. W. Winkelman Company, Syracuse, N. Y.

AIME, Harry J. O'Carroll, Kennecott Copper Corporation, New York, N. Y., George B. Corless, Standard Oil Company (N. J.), New York, N. Y., Max W. Lightner, Carnegie-Illinois Steel Company, Pittsburgh, Pa.

ASME, George W. Codrington, General Motors Corporation, Cleveland, Ohio, Ralph L. Goetzenberger, Minneapolis-Honeywell Company, Philadelphia, Pa., Carey H. Brown, Eastman Kodak Company, Rochester, N. Y.

AIEE, O. W. Eshbach, Northwestern University, Evanston, Ill., A. C. Monteith, Westinghouse Electric Corporation, Pittsburgh, Pa., H. A. Winne, General Electric Company, Schenectady, N. Y.

AIME, W. I. Burt, B. F. Goodrich Chemical Company, Cleveland, Ohio, C. G. Kirkbride, Houdry Process Corporation, Wilmington, Del., F. J. Curtis, Monsanto Chemical Company, St. Louis, Mo.

ASEE, Harry H. Armsby, Office of Education, Washington, D. C., S. C. Hollister, Cornell University, Ithaca, N. Y., Thorndike Saville, New York University, New York, N. Y.

D. B. Prentice, Mem. ASME, Director of Scientific Research Society of America, has been appointed executive secretary of the new Commission.

Two Responsibilities Assumed

Specifically, the new Commission has been charged by the EJC with two responsibilities: (1) Developing policies and procedures designed to secure the most effective use of engineering skills and experience in industry and government (civilian and military) during any future emergency; and (2) taking the necessary steps within the scope of EJC to put such policies and procedures into practice.

What the NSRB is after, according to Mr. Clark, is some practical method of reserving from military duty individuals possessing specific engineering skills until such time when each can be inducted into the armed or government services on the basis of military requisition for a specific skill. Some workable system for moving skilled personnel between military and industrial assignments is also sought. Such a method of husbanding precious skills would be a departure from traditional induction methods and would introduce a host of questions which call for study.

While the EJC will limit its study of skilled man-power induction to considerations of engineering personnel, three other organizations, the American Chemical Society, The Institute of Physics, and the National Research Council, each of which received similar invitations from the NSRB, will consider the same problems as they relate to chemists, physicists, and scientists other than engineers.

In suggesting a method for deferment of engineers, the new commission faces two difficult problems: (1) How to determine what individuals should be covered by any proposed plan; and (2) what procedures should be set up to determine and to obtain the desired allocation of various individuals covered by the plan.

In the first case the commission will concern itself with establishing (1) specific standards for training and experience and in defining specific skills; (2) methods of getting information about individuals; and (3) aids for deciding whether a specific individual comes under the plan. The relationship of any proposed plan to the Selective Service registration and other scientific and engineering personnel roster will have to be worked out.

In the second case, the Commission will take up methods for (1) reviewing allocation requirements of the military, industry, civilian agencies, universities, and others; (2) maintaining a continuous review of current priority of allocation previously determined; (3) deciding on best methods of achieving the desired distribution of specialists among competing claimants and other complex problems.

No Special Concessions Asked

In accepting the task laid down for the EJC, E. H. Robie, secretary EJC, in a letter to NSRB said: "Engineers look with tremendous satisfaction on the contribution made by them during World War II in building the production plan and in developing production methods—one of the many reasons why the United States became the Arsenal of Democracy. This nation's tremendous technological resources, used without waste, provide an assurance of eventual victory. One important element is our engineering skill and experience, primarily in production and construction. This element must not be wasted and Engineers Joint Council will do its best to reduce that waste."

"In approaching this problem, EJC wants to make it completely clear that engineers are not asking for any special concessions. They are merely asking for the opportunity to apply their skills where these skills will be of greatest use. They are placed in the industries serving civilian economy as well as in the industries serving defense establishments and in the defense establishment itself where engineers will be needed. It will be the effort of Engineers Joint Council in meeting your request to attempt to develop a procedure that will assure to the nation the best utilization of engineering skills wherever employed."

Other EJC Business

At the same meeting EJC received a report on completion of the survey of key engineering personnel conducted for the Office of Naval Research (see page 773–774, October, 1950, issue) and the creation of an engineering committee to advise the Civil Service Commission (see page 838 of the October, 1950, issue). EJC also learned that its recommendations relating to the preservation of professional status of engineers in the new Army Reorganization Act signed by President Truman on June 28, 1950, were included in the Act. Engineers were specifically named as one of the learned professions along with those of medicine, law, and theology.

EJC also has under consideration an immediate study of an approach to a survey looking toward a national policy on fuels. Eventually a survey will be fostered by an EJC panel, perhaps patterned on the EJC Water Policy study and report.

Survey Reveals Shortage of Competent Industrial Engineers

A SHORTAGE of competent industrial engineers and the need for training men for jobs at all management levels was disclosed recently in a survey by the Association of Consulting Management Engineers, New York, N. Y. Speaking for 33 of the foremost consulting firms of the country, the Association report stressed that skilled man power is in even shorter supply than materials. "If I were the head of a company I would make the development of men my chief concern," the head of one firm of management consultants stated.

Expecting salaries and wages to be frozen, many clients of consulting firms are now evaluating or re-evaluating all positions, both rank and file, managerial and staff. Rates of pay for various jobs are being established in line with going rates in the area for comparable positions, the report indicated.

"During the last war companies with well-developed and maintained position and job-evaluation programs had little difficulty with the Salary Stabilization Unit and the War Labor Board," the report pointed out.

However, while man power is of paramount importance, "every phase of the management problem needs review, and time is the essence. Loss of present markets through rationing, conversion to war work, protection of the labor supply, and the necessity for keeping wage rates in step with current conditions, and ahead of any wage freeze," are all part of the same problem facing management today.

Warning against a too rapid break-up of the sales force, consultants pointed out that in the last war many firms converted too far away from peacetime work. "Those who can do something for the war effort should do their patriotic best, but the government will thank no business for rushing out of civilian work if it has nowhere to go in war work. The greater part of our economy will still be concerned with civilian business."

A policy of complete flexibility with respect to operating problems will have to be maintained for a while, but "strangely enough, the farther this mobilization goes, the less flexible will the manufacturer have to be," one member stated.

A prediction that rearming of the United States and the United Nations will take 25 per cent to 30 per cent of our man-hours, highlighting the need for greater productivity, was made by a member who also predicted that "we shall have controls on selected commodities and some sort of a wage and price freeze."

A significant difference in the economy today, compared with World War II, is that there is not the great necessity this time to build new synthetic rubber plants, airplane factories, chemical and explosive plants. "Today we have adequate plant capacity for the bulk of our war materials," the consultants agreed, and now higher productivity is the top need.

"It is the responsibility of government to utilize its capital and reserves of man power to their maximum efficiencies. This can be determined in the case of the college men by their demonstration of their capacity to think clearly, to survive in intellectual competition, and to have the will to lead in national service. These three factors lie at the base of national planning for the future. . ."

Program Suggested for Trebling U. S. Scientific Man Power

THE U. S. must treble its scientific man power in order to maintain the "knowledge stockpile now absolutely necessary for national survival."

This warning was issued recently by John S. Nicholas, professor, Yale University, who asserted that the present number of U. S. scientists is adequate only "for peacetime needs."

Professor Nicholas said that in the advancement of basic science, upon which improvements in technology depend, "we are in competition with keen scientific minds that already have access to much of the same knowledge stock pile that we have.

"It was not an unplanned action when Russia transported most of the atomic scientists of Germany to an unknown location deep in Russian territory. They also have developed a highly competitive technological educational program in which, by order, a large proportion of their man power between the ages of 18 and 26 is engaged.

"Their stockpile of scientific man power will exceed ours in number by 1953. We must be alert to this or face the results of their careful preparation."

Professor Nicholas suggested a three-point program for meeting the nation's future scientific needs. He called for: (1) Early selection of outstanding minds with scientific aptitudes; (2) granting these minds the privileges of rapid and rounded education; and (3) subsidizing after selection those who are creative scientists.

The increase of scientific man power, he continued, is absolutely necessary today in a situation which calls for a long period of immediate preparedness. War itself depends more and more on trained technicians. The technicians would have nothing to do if scientists were not producing the information that can be engineered into technical machinery.

"If we as a nation will survive," Professor Nicholas declared, "we must continue the educational flow of man power in scientific fields . . . by the intelligent use of what we have to draw upon—the young, alert members of American society who can easily be shown where their brains and energies can best be used for the national welfare and defense."

"Our present national concept of education is that it is a material right which is largely taken for granted. Under the new condition of national danger it becomes a privilege to be had only by those whose purpose it is to further their intellect with the future outlook of its national as well as its personal service. It carries with it a definite responsibility to the nation and the duty of performing national service.

U. S. Man-Power Potential

CURRENT man-power potential in the United States would allow an armed force of 12.5 million, 11.2 million over June, 1950, limits; an increase in the war industries labor force of 3.2; and decrease in the civilian industry labor force of 6.6 millions.

These and many other related data on U. S. man power are reported by the United States Department of Labor in its special publication "Labor Market and Employment Security."

Of the 66.2 million in the labor force, 95 per cent were employed in June, 1950. Of these, 4.5 million were professionals and 11.9 were semiskilled workers.

In a breakdown by industries, 6.3 million were in metalworking industries, 8.3 in other manufacturing, 9.1 in agriculture, and 37.8 million in the nonmanufacturing group.

Manufacturing employment, the report shows, is concentrated in a few states. In April, 1950, four states, New York, Illinois, Ohio, and Pennsylvania, had more than a million workers in manufacturing, while five states, California, Indiana, Massachusetts, Michigan, and New Jersey, had between one-half and a million such workers.

In metalworking industries, employment in June, 1950, was well below the wartime peak. In aircraft, decline since 1943 was 88 per cent, in shipbuilding it was 92 per cent.

Applied Mechanics Reviews Transfers Editorial Offices

EFFECTIVE with the October, 1950, issue of *Applied Mechanics Reviews*, editorial responsibility has been transferred from the Illinois Institute of Technology, Chicago, Ill., to Midwest Research Institute, Kansas City, Mo., where the *Reviews* will be under the editorship of Martin Goland, Mem. ASME, and chairman of the Institute's Engineering Mechanics Division.

Applied Mechanics Reviews, now in its third year of operation, is published by The American Society of Mechanical Engineers and the following co-operating organizations: Office of Air Research, Midwest Research Institute, American Society of Civil Engineers, Institute of Aeronautical Sciences, American Institute of Physics, American Mathematical Society, Society for Experimental Stress Analysis, The Engineering Institute of Canada, and The Institution of Mechanical Engineers.

This monthly journal, which presents critical reviews of the world literature in applied mechanics, has been hailed as a "must" tool for research personnel in universities, government and industrial research laboratories, and industry in general, throughout the world.

Conference Discusses Problems of Administration of Research

THE greatest gamble a company can make is to have no research program at all," was the keynote message of James C. Zeder, director of engineering and research, Chrysler Corporation, in emphasizing the role of technological research in industrial planning, before the fourth annual Conference on the Administration of Research.

More than 150 research executives from industry, government, and educational institutions participated in the invitational program held under the auspices of the Engineering Research Institute and College of Engineering, University of Michigan, Ann Arbor, Mich., Sept. 11, 12, and 13, 1950. Papers and roundtables centered on (1) calculated risk—its place in the selection, control, and termination of research projects; (2) measuring the return from research; (3) what is needed in a research executive; (4) overhead—as a factor in sponsored research; and (5) new government services to research.

C. G. Worthington, Mem. ASME and secretary-treasurer of the Industrial Research Institute, New York, N. Y., served as chairman of the conference's advisory committee, and H. K. Work, director, research division, New York University College of Engineering, headed the program committee. C. W. Good, Mem. ASME, assistant director, Engineering Research Institute, handled meeting arrangements.

Calculated Risk

Speakers on calculated risk included T. H. Vaughn, vice-president, Wyandotte Chemicals Corporation, E. D. Reeves, executive vice-president, Standard Oil Development Company, and Donald Loughridge, senior scientific adviser, Office of the Assistant Secretary, Department of the Army. It was said that a research director should have a balanced portfolio containing "bonds" that give certain but low return; "blue chips" that provide a good return if they work out; and "gold-mine stocks" having high risk but which pay off handsomely if they are successful. It was emphasized that risk on research is risk on the future health of the organization. The vice-president in charge of research in a corporation was referred to as being the firm's technological strategist.

In the later session on qualities needed in a research executive, R. D. Stevens, vice-president, Arthur D. Little, Inc., stated that concern for the future is not the primary function of sales, production, and personnel men. It was the job of the company's research officer, through his knowledge of technological, economic, human, financial, and government matters, to make his wishes audible in determining the policies of the company.

Messrs. Vaughn, Reeves, and Loughridge were agreed that in analyzing "calculated risk," the research director must evaluate each new project and periodically re-evaluate existing projects. For new projects he must ask such questions as: Will the potential results be useful and in our line? Do we have the manpower to do it? Will we have the raw materials? Can we get the capital and where are the markets—new or old? What profits can we expect to make? What is the ratio between anticipated profit and investment? Is this ratio acceptable?

Calculated risk takes on an additional meaning in military research in that its measurement cannot be stated in terms of dollars and cents, but is involved with our freedom and security. This problem was summarized by Mr. Loughridge, who said: If we don't know it or don't do it, we are exposing ourselves to military loss.

Measuring Returns From Research

Allen Abrams,[1] vice-president, Marathon Corporation, Rear Admiral W. S. Parsons, U.S.N., and C. G. Suits, vice-president, General Electric Company, spoke on measuring the return from research. While various bases are utilized in many companies, these speakers were in agreement on the difficulty of devising accurate methods, which makes it tough on the research director in justifying program expense to his board of directors, and tough on the individual researcher because he would like to know just how much good he is doing. Nevertheless, growth of industrial, government, and university laboratories in the last 20 years has been phenomenal. Dr. Suits cited the development of Formex insulation which although more costly than the enamel previously utilized to insulate wires, was so much better that it led to electric motors of considerably reduced size. How could the value of this individual development be accurately figured? he asked. What value, moreover, could be placed now or in the foreseeable future on "Project Cirrus," the cloud-seeding program? Measuring the return from exploratory research was particularly difficult because the results were entirely unpredictable and unknowns were involved at every point. Research, engineering, production, and marketing were in total, the basis of profits, Dr. Suits stated.

The problem of research evaluation, the conference concluded, was not that of an evaluation of a specific project, but that of determining what factors influence management to make effective decisions on research expenditures and effort. As one commentator said, "Research need not depend on an index of value. It has to be something of a religion."

Admiral Parsons spoke on operational research which began in the military and was rapidly spreading to industry as the application of probability and theory of error to numerical systems of thinking. While it is possible to measure the cost of sinking a battleship or shooting down a plane, how can one measure the cost of defeat? he asked. Admiral Parsons outlined the growth of the Weapons Systems Evaluation Group and concluded: "But in its over-all view, the measure of return from research in this anxious decade will be the degree to which it increases our stock pile of flexibility, resourcefulness, and alertness, both in human and material fields."

Research Costs

Large Federal research expenditures in the universities, resulting in additional loads on the facilities, have given new importance to the matter of overhead, W. K. Pierpont reported. Research costs are arbitrarily divided into direct costs (labor, supplies, equipment, etc.) and indirect costs or overhead. The measure of the latter is determined by what the accountant, comptroller, or other fiscal officer decides should be direct and what should be indirect. A uniform overhead figure for all university and government agencies does not appear feasible, he said, in suggesting that much of the argument on the overhead percentage might be eliminated by the mutual adoption of a more uniform agreement on what is direct and what is indirect cost.

Proceedings of the 1950 conference will be published in about six months by the Engineering Research Institute, University of Michigan. Proceedings of previous conferences are available through the Engineering Experiment Station, The Pennsylvania State College, State College, Pa.

[1] A paper by Mr. Abrams on "Appraising Returns From Research," appeared in the August, 1950, issue of MECHANICAL ENGINEERING, page 645–646.

Engineers Advocate State Control of Water Resources

SOME 1400 engineers of the Pacific Northwest have organized a group called "Independent Engineers for Private Enterprise" headed by F. R. Schanck, consulting engineer, Portland, Ore. The object of the group is to foster state control of local and regional water resources.

The group contains no engineers who are employed by Federal agencies or public utilities.

In a statement before the President's Water Resources Policy Committee, an IEPE committee asked that Congress not enact detailed or restrictive laws relating to water resources because the importance of these resources varies so widely in different parts of the United States.

Federal legislation touching on bodies of water wholly within a state was unwise, according to the committee. Regarding interstate waters, the committee recommended that Congress consider only legislation contributing to wise and efficient control of local and regional water resources by the United States.

The group has also drafted a "Columbia River Basin Compact" which has been submitted for action to the governors of the seven states of the Columbia River Basin. The basic idea of the compact, which envisages some sort of an agency as the Colorado River Commission or the Port of New York Authority, is that the states have the right and duty to solve problems arising from development and conservation of the national resources by independent and co-operative action.

Educational Exhibits to Be Feature of 1950 National Power Show

MORE than 300 manufacturers in the power industry will demonstrate what is new and useful in the way of cost-reducing products and services at the 19th National Exposition of Power and Mechanical Engineering to be held at the Grand Central Palace, New York, N. Y., Nov. 27-Dec. 2, 1950. Known to all mechanical engineers as the National Power Show, the exposition for the first time in its long history will be held under the auspices of The American Society of Mechanical Engineers whose Annual Meeting at the Hotel Statler, Nov. 26-Dec. 1, will run concurrently with the Exposition.

Limited to executives, technical, and operating men interested in power plants and allied equipment, the show will open at 2 p.m. on Monday, Nov. 27. On the following days the hours will be from 11 a.m. to 10 p.m., except on Wednesday and Saturday, when the closing hour will be at 6 p.m.

The show will feature improved methods and equipment for treating fuel before it enters the combustion chamber providing a wider latitude in the selection of fuel, more efficient power oil burners, blowers, draft equipment, smoke-prevention equipment which reinjects into the furnace unconsumed hydrocarbon particles retrieved from the flue gases, and many other cost-reducing products.

Educational Exhibits

Numerous displays have been developed to perform an educational function. For example, the Tubular Exchanger Manufacturers Association has designed an exhibit covering the need for higher standards in design of heat exchangers which many power engineers should find worth study. Another exhibit shows a typical pressure-loss testing hookup for use in valve design. This hookup demonstrates comparative flow characteristics using half-section models of conventional and streamlined valve bodies, emphasizing the superior opening action and lower pressure-drop of newly developed piston-type check and stop-check designs. One oil company will have on display a model sleeve bearing to demonstrate pressures developed by the rotation of the journal. At the same booth there will be a plastic model of a turbine in which some new ideas on the problem of turbine lubrication will be demonstrated. For engineers working in vibration control there will be an exhibit demonstrating rubber-bonded parts designed for simplifying assembly which can be used for vibration control. Of interest also will be a display of stainless-steel bellows and flexible hose which will feature stainless-steel assemblies for jet aircraft and flexible high-pressure pipe-line expansion joints capable of withstanding pressures up to 1500 psi.

Instruments

Instruments manufacturers will have on exhibit their latest refinements to instruments for indicating and recording temperatures, pressures, liquid levels, rates of flow, weights and measures, and chemical analyses, and many others which perform a fact-finding function in and around a power-generating station. Most spectacular advances in this field relate to remote indication and control. Under one system of combustion control the change in the electrical load for the first time is used to initiate a corresponding change in the combustion-control hookup without waiting for a change in steam pressure.

Reflecting the current revival in smoke abatement and fuel conservation, the show will have many products which power engineers will inspect with interest.

The scope of the Power Show includes a wide range of auxiliary equipment suitable for all manner of industrial plants as well as generating stations. They are steam and Diesel engines, packaged boilers with high efficiencies considering their relatively small size, power transmissions, conveyer systems, and material-handling equipment in considerable variety. In addition there will be an array of electrical apparatus exclusive of signal systems and control.

U. S. Engineers Invited to Festival of Britain

MEMBERS of The American Society of Mechanical Engineers are invited to participate in a joint engineering conference sponsored by the Institutions of Civil, Mechanical, and Electrical Engineers to be held in London, England, June 4-15, 1951, as part of the Festival of Britain.

The purpose of the conference will be to place on record the contribution to civilization made by engineers during the past 100 years.

Among the subjects to be discussed will be road and sea transportation, power, railroads, aviation, education and training, mining, water supply, sewerage and sewage disposal, electrical measurements, television, and others.

In addition to the technical discussions, a full program of social events and visits to industrial plants and places of historic interest is being arranged.

For further information about the conference, write to The Secretary, The Institution of Mechanical Engineers, Storey's Gate, London S.W. 1, England.

The Mechanical Engineer—A Mainstay of the Petroleum Industry

ASME Petroleum Division Organized to Serve Industry

THE American petroleum industry with its ubiquitous products and services depend on the mechanical engineer for its ability to bring petroleum products to the consumer in sufficient quantity, of adequate quality, and at a cost commensurate with their usefulness, according to E. W. Jacobson, chairman, Petroleum Division of The American Society of Mechanical Engineers, and chief design engineer, Gulf Research and Development Company, Pittsburgh, Pa. Speaking at the Division's Fifth Annual Conference on Petroleum Mechanical Engineering in New Orleans, La., recently, Mr. Jacobson reviewed the organization and growth of the ASME Petroleum Division which, he said, has won the support of the petroleum industry.

Of the present 32,000 members of the ASME, Mr. Jacobson said that at least 5000 were directly or indirectly in some phase of the petroleum industry. To provide an outlet for new ideas and a workshop for the application of these ideas, the ASME petroleum mechanical engineers organized a Petroleum Committee in 1944. After three conferences in Tulsa, Okla. (1946); Houston, Tex. (1947); and Amarillo, Tex. (1948); the Committee gained Division status. The 1949 Conference held in Oklahoma City, Okla., was the first sponsored in its capacity as a Division.

Of the 5000 or more ASME members in the petroleum industry, a great number were employed in the design and equipment-manufacturing phase of the industry. Membership of oil company personnel, he estimated, was outnumbered by membership from service companies. In organizing the Petroleum Division an effort was made to place the service-company engineers on an equal footing with those in the producing companies. The wisdom of this plan was evidenced in the high technical level of the papers and the support by the industries of the annual conferences sponsored by the Division.

The Division's committee setup, Mr. Jacobson said, was rather obvious. Emphasis is given to production, transportation, and refining. The manufacturers' group has its own committee and because of the importance within the industry of the selection of proper materials, the Division also has an active Materials Committee. There is also a Product Applications Committee which was currently co-ordinating the lubrication program of the ASME. Recently the Division appointed a publicity secretary and a research secretary.

An important aspect of the Division's work was its interest in engineering students with a preference for the petroleum industry, Mr. Jacobson continued. Because of the industry's need for exceptional engineering talent, the Division's Student Committee offered a prize for an outstanding paper on petroleum mechanical engineering prepared by an undergraduate ASME student member.

Mr. Jacobson stated that mechanical engineers who were not yet members of the ASME could benefit fully from the work of the Petroleum Division by joining the Society and serving on its many committees.

UNESCO Book-Coupon System Hurdles Currency Barrier

THE Book-Coupon System of UNESCO has aided the exchange of some $700,000 worth of books, mostly scientific and medical, among 18 participating countries since it was inaugurated in 1948, according to the September, 1950, issue of UNESCO *News*.

The plan has been highly successful in hurdling one of the barriers to the free flow of information among countries—the currency barrier between the so-called "soft" and hard-currency nations. Soft-currency nations are reluctant to use their hard-currency reserves for educational, scientific, and cultural materials. (See MECHANICAL ENGINEERING, April, 1949, page 356.)

Under the UNESCO book-coupon plan persons in war-devastated countries or the soft-currency countries buy UNESCO book-coupons with their own currencies. They use the coupons to pay for books purchased from hard-currency countries.

Publishers redeem the coupon in the currency of their own country from UNESCO book-exchange fund.

To finance the plan UNESCO relies on contributions from hard-currency countries such as the United States and Canada. To increase its hard-currency reserves, UNESCO has formulated a plan under which libraries of hard-currency countries may purchase books from soft-currency countries by use of the coupon system.

The United States is the largest book-selling country in the project. The American Booksellers Association, New York, N. Y., administers the plan in the United States. The Association reports that the majority of orders are for scientific, particularly medical books, and that India is at present the "best customer."

Registration Law Signed for Washington, D. C.

PRESIDENT Truman recently signed an engineering registration law for the District of Columbia which becomes effective in December, 1950. The law will require registration examinations only if the record of the applicant does not meet established standards.

Qualification will be on the basis of graduation from an accredited engineering school plus four years of responsible engineering experience or twelve years of engineering experience without formal engineering education.

The law also provides for registering professional engineers of other states through reciprocity. Professional engineers who have resided or practiced in the District for the past year may be registered without examination.

The law will be administered by a five-man board, appointed by the Commissioners from lists submitted by the representative engineering societies. The board will be representative of the basic branches of engineering.

Educators Examine Air Transportation

WHETHER or not engineering colleges have contributed as much as they could to training of engineers and executives for air-transportation business was one of the questions discussed at the Conference on Ground Facilities for Air Transportation sponsored by the Massachusetts Institute of Technology, Cambridge, Mass., Sept. 14, 1950.

According to A. J. Bone, associate professor of highway and airport engineering, M.I.T., one of the principal objectives of the conference was to investigate whether or not ground phases of air transportation have kept pace with the air phase.

Few colleges, Professor Bone said, offered full-length courses leading to a degree in air transportation. In recent years most engineering colleges have introduced airport design into their civil-engineering curriculum, but, he added, there appeared to be little coordination between aeronautical-engineering courses and airport design.

Design, construction, and operation of an airport and of the ground facilities involves a knowledge of many fields, the specialists of which can be found under one roof or on one campus of many engineering schools. Professor Bone suggested that the engineering schools should draw upon these talents to provide educational opportunities in the broad field of air transportation.

Exploring further how special studies in air transportation could be organized by the colleges, Professor Bone suggested a program of seminars sponsored jointly by the civil, aeronautical, electrical, city planning, and business departments, to which speakers who are active in each of the larger branches of air transportation could be invited.

Another approach, he said, would be to hold conferences attended by specialists who are active in the many branches of air transportation.

Three Principles of Industrial Safety Formulated

THREE principles fundamental to labor-management co-operation for industrial saftey were published in Bulletin No. 121, "Report on Labor-Management Co-operation for Safety," by the U.S. Bureau of Labor.

The principles were drafted by a committee of the President's Conference on Industrial Safety composed of representatives of labor, industry, educational, insurance, and safety organizations. The aim of the Conference, which has already met twice, is a long-term program of co-operative action which can reduce industrial accidents by 50 per cent by 1952.

The principles follow:

1 Safety primarily is the legal and moral obligation of the employer. The employer must have a sincere and continuing interest in providing for the safety of employees. This interest is demonstrated by: (*a*) Initiation of a sound safety program with the policies, procedures, and staff necessary to make it effective, (*b*) provision of safe working conditions, machinery, and equipment and personal safety protective devices and apparel where necessary, (*c*) development of effective training programs for supervisors and employees, (*d*) encouragement of employee interest and participation by making available channels through which employees may offer suggestions, advice, and recommendations for the improvement of safety.

Management must have the authority necessary to carry out its responsibility. No steps should be taken which create confusion and uncertainty as to management's responsibility and authority.

2 Co-operation in the safety program is the moral obligation of each individual employee. This is demonstrated by: (*a*) Working safely at his job, (*b*) having regard at all times for the safety of fellow employees, (*c*) using his knowledge and influence to prevent accidents, (*d*) calling attention to unsafe conditions, and (*e*) contributing his ideas, suggestions, and recommendations for the improvement of safety.

3 In unionized plants the welfare of the employees places upon the labor union a moral obligation to co-operate in accident prevention, within the framework of its agreed-upon participation. This is demonstrated by: (*a*) Taking its agreed part in the safety program in the plant, (*b*) using its influence in encouraging the employees it represents to work safely, and (*c*) promoting accident prevention through its publications, union meetings, and education courses, with emphasis not only upon plant safety but also with due regard to safety in the home, on the highway, and in other activities outside the plant.

F. J. Graf, chief engineer, Massachusetts Bonding and Insurance Company, Boston, Mass., and E. R. Granniss, manager, engineering department, Eagle-Globe-Royal Indemnity Companies, New York, N. Y., represented the ASME at meetings of the Conference.

Coming Meetings

Plant Maintenance

THE Plant Maintenance Show will be held in the Public Auditorium, Cleveland, Ohio, Jan. 15-18, 1951. A plant-maintenance conference will be held concurrently consisting of four general sessions and eight sectional conferences.

L. C. Morrow, consulting editor, *Factory Management and Maintenance*, will serve as general chairman.

Preventive maintenance will be the first topic at the general sessions. The sessions will divide into four sectional conferences on specific maintenance problems. The topics to be covered will be maintenance of electrical

equipment, power-plant and heating equipment, maintenance problems of the small plant, and selection and maintenance of lighting equipment.

The American Society of Lubrication Engineers will conduct a panel on lubrication on the third day of the conference.

Air Conditioning

The Tenth International Heating and Ventilating Exposition will be held at the Commercial Museum, Philadelphia, Pa., Jan. 22–26, 1951, in conjunction with the 57th Annual Meeting of the American Society of Heating and Ventilating Engineers. Five technical sessions are planned on smoke measurement, solar radiation, air flow and its measurement, and heat-pump performance.

International Exhibition

THE Indian International Engineering Exhibition will be held at New Delhi, India, during January, 1951. During the exhibition the following international conferences will be held: The Fourth Congress on Large Dams, The Sectional Meeting of the World Power Conference, and The Meeting of the International Association of Hydraulic Research. It is also proposed to hold a meeting of the newly formed International Commission on Irrigation and Canals.

The exhibition will be devoted to latest developments and techniques covered by the international conferences. For further information, write to the Consulate General of India, 3 East 64th Street, New York 21, N. Y.

RESA

THE annual convention of the Scientific Research Society of America will be held in the Otis Room, Allerton Hotel, Cleveland, Ohio, 4:00 p.m., Dec. 29, 1950. It will follow the Sigma Xi Convention to be held in the same room beginning 2 p.m. The two conventions will be part of the annual meeting of the American Association for the Advancement of Science to be held in Cleveland during the week of Sept. 26. A feature of the RESA convention will be an evening meeting at which E. V. Murphree, president, Standard Oil Development Company, will speak. The meeting will be held in the ballroom of the Allerton Hotel.

The RESA session will be the third in a symposium under the general subject of the partnership of engineering and science in research. The first two sessions will be held in the morning and afternoon of Dec. 29 and will be sponsored by Section M (Engineering) of the AAAS.

AAAS

SECTION M (Engineering) of the American Association for the Advancement of Science will hold eight sessions during the 1950 AAAS annual meeting to be held in Cleveland, Ohio, Dec. 26–30, 1950. The Section M program follows:

Tuesday evening, Dec. 26, M. A. Edwards will speak on "What's New in Development Engineering." The Cleveland Section of The American Society of Mechanical Engineers will cosponsor this session.

Wednesday afternoon, Dec. 27, four speakers will discuss such topics as "Social Physics," "Dynamics of Economic Growth," "Dimensional Analysis in Social Physics With Testing of Gravitation Dimensions," and "The American Chemical Industry and Its Regularities in Production, Distribution, Competition and Product Distribution."

Wednesday evening, Dec. 27, C. C. Furnas will speak on "Partners in Research." This session is being cosponsored by the Cleveland Engineering Society.

Thursday afternoon, Dec. 28, a symposium on Bioengineering will be offered. Speakers and the subjects will be: O. Glasser, "Introductory Survey of Bioengineering"; A. P. Gagg, "The Human Body as a Limiting Factor in Aeronautical Engineering"; R. D. Evans, "The Human Body and Nuclear Engineering"; "The Individual as a Limiting Factor in Industrial Engineering"; G. E. Barnes, "Health as Affected by Sanitary Engineering."

Friday morning, Dec. 29, Symposium on "Partnership of Science and Engineering in Research." Morning session, W. B. Bartlett, "Nuclear Science in Engineering School Curriculum"; "Relations Between Nuclear and Electrical Engineering"; L. B. Borst, "Prospect of Industrial Atomic Power."

Afternoon session, C. P. Straub, "Recent Developments in the Treatment and Disposal of Radioactive Waste Liquors"; J. N. Stannard, "Problems in the Establishment of Maximum Permissible Radiation Exposure Levels."

Evening session, to be held in the ballroom of the Allerton Hotel, at which E. V. Murphree will speak. The evening session will be cosponsored by the Scientific Research Society of America.

ASRE

THE 46th annual meeting of the American Society of Refrigerating Engineers will be held at the Hotel Commodore, New York, N. Y., Dec. 3–6, 1950. Among the speakers will be Vilhjalmur Stefansson, artic explorer and author, who will explain how the permanently frozen ground of artic regions can be utilized to advantage, and discuss some of the problems which will arise in such an operation.

Meetings of Other Societies

Nov. 9–10
Society of Automotive Engineers, Inc. national meeting, The Mayo Hotel, Tulsa, Okla.

Nov. 13–16
American Petroleum Institute, 30th annual meeting, Biltmore Hotel and The Ambassador, Los Angeles, Calif.

Nov. 27–29
American Standards Association annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Dec. 3–6
American Institute of Chemical Engineers, annual meeting, Neal House, Columbus, Ohio.

Dec. 3–6
The American Society of Refrigerating Engineers, 46th annual meeting, Hotel Commodore, New York, N. Y.

(F&P ASME Calendar of Coming Events see page 944)

Engineering Literature

Flow and Fracture of Metals

A SELECTED bibliography of comprehensive treatises on the flow and fracture of metals has been compiled by the Materials Division of the Pressure Vessel Research Committee of the Welding Research Council. The bibliography is the result of a review of some 3000 technical papers dealing with fundamental concepts of the flow and fracture of metals under various types and combinations of stress and throughout the temperature range to which metals are exposed in service. The bibliography lists the treatises which collectively are representative of the prevailing state of knowledge and theory concerning the complexities involved in the flow and fracture of metals, and which are recommended to investigators who want to understand the fundamentals of the subject but do not have the time to examine an extensive literature.

For copies of the bibliography, write to Materials Division, The Pressure Vessel Research Committee, Welding Research Council, 29 West 39th Street, New York 18, N. Y.

Large Rivets

THE American standard for Large Rivets 1/2 In. Nominal Diameter and Larger (ASA B18.4–1950) was recently published by The American Society of Mechanical Engineers. The standard is a revision of one originally published in 1937. The new standard incorporates only one major dimensional change: Pan-head rivets were changed to conform with the American Bureau of Shipping and the U. S. Navy design. The change was made because all manufacturers with one exception were making pan-head rivets to these standards.

The 14-page standard covers Button Head, High Button Head (Acorn), Flat-Top Countersunk Head, Round-Top Countersunk Head, Cone Head, and Pan Head Rivets. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is 80 cents.

Lock Washers

THE American Standard Lock Washers (ASA B27.1–1950) was recently published by The American Society of Mechanical Engineers.

The 18-page standard, which is a revision of the 1944 edition, covers dimensions, physical properties, and methods of testing of spring lock washers in various materials: carbon steel; stainless steel Type 302; stainless steel Type 420; aluminum-zinc alloy; phosphor bronze Grade A; silicon bronze Type B; and K-Monel.

Tooth lock washers with internal teeth, tooth lock washers with external teeth, and tooth lock washers with both internal and external teeth are covered.

Price per copy is 75 cents. Copies may be obtained from the Order Department ASME, 29 West 39th Street, New York, N. Y.

People

C. R. Hook Awarded 1950 Gantt Medal

CHARLES R. HOOK, Sr., chairman of the board, Armco Steel Corporation, Middletown, Ohio, received the 1950 Henry Laurence Gantt Memorial Gold Medal for "distinguished achievement in industrial management as a service to the community," on Oct 3, 1950, at a luncheon meeting during the Personnel Conference of the American Management Association, Hotel Statler, New York, N. Y.

The Henry Laurence Gantt Gold Medal Award was established in 1929 to memorialize the distinguished achievements and great service to the community rendered by Henry Laurence Gantt, management engineer, industrial leader, and humanitarian. The award is made annually by a board composed of representatives of the American Management Association and The American Society of Mechanical Engineers.

The award cites Mr. Hook as a distinguished industrial executive and humanist whose pioneer work in the development of far-seeing policies in the field of human relations within his company became the foundation of a company-community-employee team imbued with that spirit of mutual confidence and respect which is essential to industrial peace.

Among the distinguished recipients of the Gantt Medal are the following: Wallace Clark, William L. Batt, P. E. Holden, Dexter S. Kimball, Lillian M. Gilbreth and Frank B. Gilbreth (posthumously), and Paul Hoffman.

* * *

J. A. HUTCHESON, Mem. ASME, was appointed to the Committee on Ordnance of the U. S. Research and Development Board. Dr. Hutcheson is director of research, Westinghouse Electric Corporation, Pittsburgh, Pa.

* * *

WILLIAM L. BATT, SR., past-president and Hon. Mem. ASME, former vice-chairman of the War Production Board, will become chief of the Economic Co-Operation Administration mission to Britain about Nov. 1, 1950, according to a recent announcement. Mr. Batt is president of SKF Industries, Philadelphia, Pa. He served on President Roosevelt's mission to Moscow in 1941, heading the raw-materials branch.

C. R. HOOK, SR., RECIPIENT OF 1950 GANTT MEDAL

* * *

CHARLES ERWIN WILSON, president, General Motors Corporation, received the American Society for Metals 1950 Medal for the Advancement of Research at the annual banquet of the society held in the Grand Ballroom of the Palmer House, Chicago, Ill., Oct. 26, 1950. Mr. Wilson was the eighth scientist-industrialist to received honor.

* * *

JOSEPH L. KOPF, treasurer ASME, president, Jabez Burns and Sons, Inc., New York, N. Y., was elected president of the National Metal Trades Association at the 1950 annual convention of the association.

* * *

JOHN F. BLACK, assistant general superintendent, Youngstown Sheet and Tube Company, Indiana Harbor, Ind., was elected president of the Association of Iron and Steel Engineers, at the convention held at Public Auditorium, Cleveland, Ohio, Sept. 26–29, 1950, in conjunction with the 1950 iron and steel exposition.

ASME Elects Eleven Fellows

THE American Society of Mechanical Engineers has honored eleven of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who, by virtue of their contribution to their profession and to the Society, were so honored are:

John O. Amstuz

John O. Amstuz, director and vice-president, in charge of manufacturing and engineering, Behr-Manning Corporation, Troy, N. Y., has been a pioneer in the development and application of the electrostatic coating process. He designed and built the equipment and machines for manufacture of coated abrasives, dress goods, automobile rugs, and other items. Mr. Amstuz has served as consultant on the design and construction of coated-abrasive plants in England, Germany, France, Canada, Australia, Brazil, and Argentina. During World War II he was in charge of engineering, planning, tooling, and operating a plant for Behr-Manning for the production of 14 and 18-cylinder ignition harnesses and other parts for aircraft ignition systems used on Pratt and Whitney engines. His articles have been published in several technical journals and he holds both American and British patents on his inventions.

George W. Bach

George W. Bach, chairman of the board, American Sterilizer Company, Erie, Pa., is responsible for the engineering, manufacturing, and selling of precision hospital equipment such as sterilizers, operating tables, and lights. While he was employed by Union Iron Works, manufacturers of water-tube boilers, as general manager, he developed many innovations in the design of boilers and furnaces and other structures pertaining to boilers, made many improvements in the engineering and manufacture of modern steam generators, and introduced "built-up" boilers. In 1934, when Mr. Bach went with American Sterilizer Company, he introduced new techniques in the manufacture of pressure vessels. Under his leadership practically all pressure vessels made by this company have been brought under the ASME Code and welding is used throughout; formerly, the standard practice was riveting of pressure vessels. He holds several U. S. Patents. Always active in ASME affairs, he has been instrumental in bringing at least two national meetings of the Society to the city.

In 1949 he was general chairman of the Fall Meeting of the ASME. He served as president of the American Boiler Manufacturers Association, 1924–1925.

Neil P. Bailey

Neil P. Bailey, Russell Sage professor of mechanical engineering and head of the mechanical-engineering department, Rensselaer Polytechnic Institute, Troy, N. Y., has devoted his career to teaching mechanical engineering and the improvement of the mechanical-engineering curriculum, developing up-to-date laboratories, directing well-balanced faculties to bring out a strong graduate and research program. During the war, Professor Bailey was engaged as a mechanical engineer in the research laboratory of the General Electric Company, and in 1945 he went to Rensselaer where under his leadership much progress has been made. The staff has been expanded from 14 to 40 members; a graduate program in gas turbines and jet propulsion has been developed and operated for three bureaus of the Navy, the Air Corps, and Army Ordnance; and industrial and government research has been carried on. He is the author of "Principles of Heat Engineering" and many technical articles which were published in professional journals.

James I. Banash

James I. Banash, consulting engineer, Chicago, Ill., is one of the country's foremost authorities in the field of safety and fire and accident prevention. He has specialized in fire and accident prevention in their relation to the physical and chemical sciences. Several years ago he achieved prominence for his work with artificial atmosphere high in oxygen, in relation to therapeutic application. He was with Underwriters' Laboratories, Inc., Chicago, Ill., for 12 years and became head of the casualty department. He is consulting engineer for the National Acetylene Association and is an active member of many other engineering and research societies. He was one of the founders of the American Welding Society. Mr. Banash has written many papers on oxygen and acetylene welding and cutting, safety, oxygen therapy, liquefied-petroleum gases, and various uses of containers for compressed gases.

Frank G. Brinig

Frank G. Brinig, president and general manager, Erie City Iron Works, is one of the pioneering engineers in the power-plant field. His major contribution to the power-plant industry has been his development of modern steam generators. Within his company, Erie City Iron Works, he is credited with advanced design and engineering of the products it produces, the transition from fire-tube boilers to high-pressure steam generators, and such projects as the design and construction of portable boilers, rotary salt driers, steel barges for Great Lakes service, and many others. Under his supervision sales policies were established and a system of pricing was put into effect. The incentive pay system now used in practically all phases of the company's manufacturing was developed by Mr. Brinig and its installation and operation came under his direct supervision.

The Erie Section, ASME, held a dinner at which George W. Bach and Frank G. Brinig were presented with their certificates.

Fred George Hechler

Fred George Hechler, is director, Engineering Experiment Station, professor of research, Graduate School, Pennsylvania State College, and since 1928 consulting engineer in charge of design of heating and ventilation systems for new college buildings. From 1928 to 1940 he supervised the design of and prepared specifications for the heating and ventilating installations for 21 major college buildings. Professor Hechler has served on many ASME committees, such as the Special Fluid Meters Committee, Main Research Committee, Executive Committee of the Oil and Gas Power Division, later chairman of the Division, and has been active in several other technical societies. He is the author of technical articles and bulletins on steam traps, balancing machines, heat transmission for buildings, and insulation materials and boiling refrigerants.

Oscar J. Horger

Oscar J. Horger, chief engineer of the Railway Division, Timken Bearing Company, Canton, Ohio, has made notable contributions to the advancement of the science of engineering as applied to industry. Dr. Horger supervised development of a roller-bearing-equipped inboard-type freight-car truck and conducted the tests made for the Pennsylvania Railroad to obtain road-service information on these new bearings. Later he developed the research equipment for the Canton laboratory of the company, and headed a newly created railway research department. In 1945 he was made chief engineer of the Railway Division. He is the author of many technical papers and holds numerous U. S. Patents. He has served on many engineering-society committees, local and national. He was on the executive committee of the Akron-Canton Section, ASME, 1940–1941; vice-president, 1941–1942, and chairman of the Section, 1942–1943. He is currently serving on the committee gathering data for the ASME Metals Engineering Handbook, the Professional Railroad Division and as member, Executive Committee, Canton-Alliance-Massillon Subsection of ASME.

Everett Samuel Lee

Everett S. Lee, executive engineer of the General Engineering and Consulting Laboratory of the General Electric Company, Schenectady, N. Y., has long been one of the leading figures in the engineering profession in the United States. Besides playing a prominent part in the affairs of the American Institute of Electrical Engineers, in which he served as President, 1948–1949, he has been active in The American Society of Mechanical Engineers and several other leading technical societies. In 1919 Mr. Lee was made division engineer of the General Instruments Division, General Engineering Laboratory of the General Electric Company. In 1923 he became division engineer of the Insulation Division and he was advanced to the position of assistant engineer of the laboratory in 1928, and in 1931 became chief engineer. Mr. Lee continued in this capacity until 1945, when the two laboratories were consolidated to form the new General Engineering and Consulting Laboratory and Mr. Lee was named engineer.

He was a member of the American Participating Committee for the Sixth International Congress for Applied Mechanics held in Paris, France, in 1946.

C. Richard Soderberg

C. Richard Soderberg, head of the mechanical-engineering department, Massachusetts Institute of Technology, has made notable contributions to analytical methods for solution of problems of dynamics and vibration of rotating machinery; also to the theory of working stresses and failure of materials through plastic deformation. As a designer, he has been responsible for improvements in steam turbines since 1931 when higher operating economies were obtained from higher steam pressures. His teaching is original in that he takes a comprehensive design problem as the subject matter of a course, in which fundamental principles of mechanics, thermodynamics, and metallurgy are applied.

In 1944 he was awarded the Linnard Prize of the Society of Naval Architects and Marine Engineers for a paper, with R. B. Smith, entitled "The Gas Turbine as a Possible Marine Prime Mover." He holds numerous patents related to electric machinery, steam turbines, and turbine construction and is the the author of several papers. As consultant to the Elliott Company, Professor Soderberg was connected with the development of the first marine gas-turbine power plant in the United States. Since 1940 Professor Soderberg has served on various governmental committees on jet propulsion, tanks, gas-turbine power plants for ships, and torpedo power plants as well as on many government advisory boards and councils.

Albert R. Weigel

Albert R. Weigel, research engineer, Consolidated Western Steel Corporation, Los Angeles, Calif., is credited with design of Velie Radial Aircraft Engine which received Certificate #4 from the Department of Commerce, April, 1928. He also developed methods and equipment to produce electric-welded and hydraulically expanded large-diameter thin-wall line pipe from high-tensile steel with a minimum amount of capital investment; a high-speed lightweight Diesel engine; and a method for direct reduction of iron ore by use of hydrogen. Mr. Weigel has achieved an international career as an industrial consulting engineer. He has served as consulting engineer on naval ordnance, rockets, plant layouts, and management procedures and to the Manhattan Project. He is the author of various papers on tooling, production methods, aircraft and automotive design and research. His patents include valve lifters, oil pumps, full floating windmill, gearbox, and gear drive for aircraft engines.

Harry A. Winne

Harry A. Winne, vice-president in charge of engineering policy for the General Electric Company, Schenectady, N. Y., since 1945, is a member of the staff of the president, Charles E. Wilson, but retains his headquarters in Schenectady. Virtually all of the most famous products turned out by the General Electric Apparatus Department during the war, such as, central gunnery control for the B-29 Superfortress, the automatic pilot, the turbosupercharger, the gas-turbine engine for aircraft, were developments of the design-engineering department which Mr. Winne headed before assuming his present post. During the war he was also a member of the War Projects Committee which co-ordinated General Electric's work with the War and Navy Departments. In January, 1946, Mr. Winne was appointed by Secretary of State Byrnes to a Board of Consultants to aid the Committee on Atomic Energy. Mr. Winne is in charge of the work in atomic energy undertaken by General Electric for the government.

He is the recipient of three honorary degrees: DS, Syracuse University, June, 1947, DE, Rensselaer Polytechnic Institute, June 1947; and DE, Newark College of Engineering, June, 1949. He is the author of 23 papers and holds 39 patents.

ASME NEWS

Preparations for 1950 ASME Annual Meeting Nearing Completion

As a round-up of new developments in mechanical engineering, a series of timely symposiums on problems confronting mechanical-engineering industries and a program of special events for the recent engineering graduate, the program of the 1950 Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Statler, New York, N. Y., Nov. 26-Dec. 1, 1950, adds up to one of the most comprehensive Annual Meeting programs in years. With 83 technical sessions, more than 200 papers, and a score of general-interest and social events, the program offers something for every member of the Society.

The program is distinctive in yet another way. This year the tentative program was announced in October, eight weeks in advance of the meeting. This means that the ASME program-making agencies were successful in accelerating a complex operation so that its job was completed one month ahead of the usual November deadline. For detailed program of technical sessions, see pages 843-847 of the October issue.

Civic Responsibility

The theme of the meeting will be "The Engineer and His Civic Responsibility." A. W. Robertson, chairman of the board, Westinghouse Electric Corporation, Pittsburgh, Pa., will sound this keynote at the President's Luncheon, on Monday, Nov. 26, in a speech on "The Individual and Free Enterprise." Mr. Robertson's talk will be directed to younger members of the Society. As head of one of the country's largest manufacturing organizations since 1926, Mr. Robertson has been a keen observer of forces threatening free enterprise and a student of how recent trends affect the individual engineer.

Monday at the Annual Meeting should be a profitable day for student members as well as Junior engineers. In addition to Mr. Robertson's talk, there will be a conference in the evening sponsored by the National Junior Committee which will take up one of the most important matters in the early years of a professional career. This is the problem of how best to use the first five years after graduation for professional growth.

Four speakers will address the conference. Each will suggest three to five specific things a graduate should do in one of four categories: (1) Community relations, (2) registration, (3) evening study courses, and (4) nontechnical reading. It is expected that the suggestions made by the speakers will add up to a blueprint for professional development which any young engineer can adapt to his own case.

The Wednesday program also holds much of interest for young engineers. The National Junior Committee is cosponsoring with the Management Division and the Education Committee a morning session at which advice on planning a career, and what industry expects from the recent graduate, will be given. At noon there will be the Members and Students Luncheon at which Arthur P. Adamson, Jun. ASME, and winner of the Pi Tau Sigma Gold Medal Award, will talk on "Taking a Broad View of the Scope of Your Profession."

Charles Phelps Cushing

SHERMAN CREEK POWER PLANT OF THE CONSOLIDATED EDISON COMPANY OF NEW YORK AS SEEN FROM THE OPPOSITE SHORE OF THE HARLEM RIVER

Registration Fees for Nonmembers

A registration fee of $5 will be charged nonmembers attending the 1950 Annual Meeting of The American Society of Mechanical Engineers. The fee for student nonmembers will be $1.

The following nonmembers will be exempt from the payment of the registration fee.

- Immediate family of a member (any grade)
- Authors listed in the program or their appointed representatives
- Invited discussers
- Session chairmen and vice-chairmen
- Committeemen required to attend a meeting of their committee
- Session aides
- Members of the ASME Woman's Auxiliary
- Members of the Engineering Institute of Canada
- Members of societies listed in the program
- Distinguished guests invited by the President or Secretary

For an afternoon session the Education Committee has brought together two engineering leaders, James W. Parker, past-president ASME, and S. C. Hollister, dean, College of Engineering, Cornell University, who will talk on the purposes of ECPD and policies relating to accrediting.

Luncheons and Dinners

Eleven of ASME Professional Divisions are holding luncheon and dinner programs at the Annual Meeting. These events provide the occasion for members of the Division not only to get together but also to hear some prominent person speak on a subject of current interest to the Division. At the IIRD Luncheon on Tuesday, W. R. Woolrich, dean of engineering, University of Texas, Austin, Texas, will talk on "Industrial Economy of Britain."

At the Management Luncheon on Wednesday, D. B. Mitchell, president, Sylvania Electric Products, Inc., New York, N. Y., will explain why his company operates in small plant units. In another part of the hotel the Air Cargo Day Luncheon will hear George B. Denny, moderator, Town Meeting of the Air, speak on "Public Events and Public Opinion."

James Boyd, director, Bureau of Mines, Washington, D. C., will be the main speaker at the Fuels Luncheon on Thursday. His subject will be "Change in Patterns of Fuel Supply."

Other professional divisions holding luncheons or dinners are Wood Industries, Power, Heat Transfer, and Materials Handling.

Air-Cargo Day

Tuesday, Nov. 28, will be Air-Cargo Day at the Annual Meeting. For the second year Air-Cargo Day will be sponsored jointly by the Aviation and Materials Handling Divisions of the ASME, the Institute of the Aeronautical Sciences, and the Society of Automotive Engineers. An air-cargo exhibit and an all-day program of technical sessions are planned.

Technical papers on air-cargo developments including aircraft and ground-handling facilities will be presented by Lieut. Col. L. S. Rochte, U. S. Air Force; S. S. Kreisler, Douglas Aircraft Company; George Hagemann, Ronald Press; Jervis C. Webb, Jervis B. Webb Company; and Alan F. Kelsey, Boeing Airplane Company. The exhibit to be furnished by major airlines and aircraft manufacturers will include models and pictures showing the latest air-cargo planes and ground facilities.

The Wright Memorial Lecture

The Wright Memorial Lecture will be held at 5 p.m., Tuesday, Nov. 28. The Lecture honors the memory of R. V. Wright who, as chairman of the Engineers Civic Responsibility Committee, was responsible for awakening engineers to the need of assuming political responsibility on the community and national level.

Problems in Burning a Heavy Fuel

A panel discussion which should be of interest to all power men will take place Tuesday, Nov. 28, at 8 p.m., when the Fuels and Power Divisions in co-operation with the Committee on Effect of Temperature on the Properties of Metals will take up current problems encountered in burning heavy fuel oil. These problems consist of wastage of metals at high and low temperature and the fouling of tube banks. E. F. Tibbetts, of the Lummus Company, will report on a general survey conducted by a joint committee of ASTM and ASME on trouble being encountered in present-day use of heavy fuel oil and circumstances under which these troubles occur. He will also describe the extent and experimental work now in progress to correct these troubles.

O. L. Wood of the General Electric Company will discuss the nature of the attack on metals at high temperatures, giving a historical background and an account of experience with boilers, gas turbines, and high-temperature superheaters.

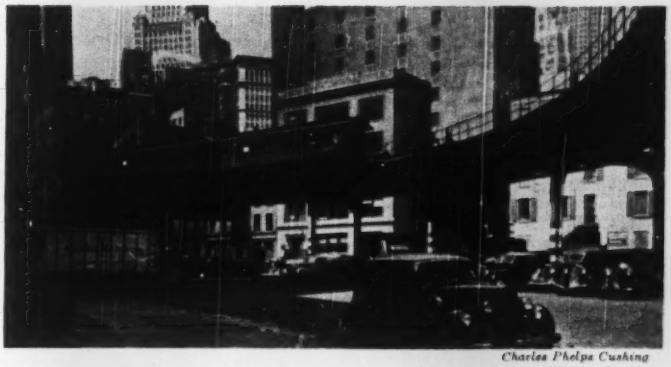
D. Douglass will discuss specific experiences at the Hartford Electric Light Company, describing nature of attack in high and low-temperature zones and methods which were used for correction. The fourth speaker, V. F. Estcourt, Pacific Gas and Electric Company, will take up correlation of slag analysis with deposit zones within the boiler, describing experience with attack on chrome-ore refractories, preliminary results in control of air-heater corrosion. He will also discuss a soot-blowing procedure as related to the problem of tube-bank fouling.

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 27, 1950, at 5:00 p.m. in the Hotel Statler, New York, N. Y., as a part of the Annual Meeting of the Society.

Members are urged to attend.



Charles Phelps Cushing

ONE OF THE DISAPPEARING LANDMARKS OF NEW YORK CITY. THIS STRETCH OF THE THIRD AVENUE "EL" WILL SOON BE RAZED. TEN BUSES WILL TRANSPORT THE 13000 PASSENGERS WHO NOW USE THE "EL" DAILY

National Power Show

This year the National Power Show will be held under the auspices of The American Society of Mechanical Engineers. Members who visit the show will note ASME influence on the show in several ways. Prominent among the exhibits will be many whose primary function will be educational and which many members will want to study closely.

The show opens Monday, at 2 p.m., and will be open every day of the Annual Meeting from 11 a.m. to 10 p.m. except on Wednesday. On Saturday, the closing day of the show, the hours will be from 11 a.m. to 6 p.m.

Inspection Trips

There will be a series of interesting plant trips arranged for visitors to New York City for the Annual Meeting. The inspection-trip program follows:

Monday morning, Nov. 27, to Hires Beverage Company, Brooklyn. Visitors will see entire production of Hires Root Beer including filler conveyer, bottle washing, packing, and shipping.

Monday afternoon, Nov. 27, to Brooklyn Union Gas Company, Brooklyn, N. Y. A modern gas manufacturing plant of 160,000,000 cubic feet daily capacity will be seen as well as production of by-products such as coke, coal tar, ammonium sulphate, and others.

Tuesday morning, Nov. 28, to Elevator Division of Westinghouse Electric Corporation, Jersey City, N. J. This plant makes all parts for elevators and electric-stairway equipment except motors.

Tuesday afternoon, Nov. 28, to Lionel Corporation, Irvington, N. J. Visitors will see die casting, stamping, plastic molding, and other operations in manufacture of Lionel trains.

Wednesday morning, Nov. 29, to the West Side Bus Terminal. This visit will be a preview of the world's largest bus terminal to be opened officially Dec. 14. It can accommodate the 2500 buses entering Manhattan daily. It is estimated that 20,000 commuters will pass through the terminal in a single peak afternoon.

Wednesday afternoon, Nov. 29, to American Machine and Foundry Company, Brooklyn, N. Y. Production of the manufacture of cigar and cigarette-making machines now in the works will be seen.

Thursday morning, Nov. 30, to Lincoln Tunnel, New York, N. Y. The land ventilating building, control room, and the CO analysis room will be visited.

Thursday morning, Nov. 30. This will be a preview of the new United Nations Headquarters, East River Drive. The building opens officially in January.

Thursday afternoon, Nov. 30. Visit to the 59th Street Station of the Board of Transportation of the City of New York.

American Rocket Society

This year, as during each Annual Meeting since 1945, the American Rocket Society will hold its annual convention as part of the ASME Annual Meeting. The American Rocket Society is an affiliate of the Society. Three technical sessions are scheduled. These will cover rocket technology, development and operations, and testing. The ARS Annual Dinner and Honors Night will be held on Thursday when engineers who have distinguished themselves in rocket technology will be awarded ARS fellowships and awards.

College Reunions

During Annual Meeting week many college alumni associations are planning reunions to take advantage of the large number of mechanical engineers from all parts of the country who will be in New York. Luncheon and dinner programs are planned. Information on reunions available at press time follows:

Brown University: Luncheon, 12:30 p.m., Thursday, Nov. 30, 1950, Advertising Club, 23 Park Ave., New York, N. Y. Contact John J. Scofield, 286 Fifth Ave., New York, N. Y. Phone: WI 7-4146.

Clarkson College: Dinner, 6:30 p.m., cocktails, 5:30, Thursday, Nov. 30, 1950, Building Trades Club rooms, 2 Park Ave., New York, N. Y. Contact John M. Cole, 342 Madison Ave., New York, N. Y. Phone: MU 2-7017.

The Cooper Union: Reunion, Thursday evening, Nov. 30, 1950, Room 6-H, Hewitt Building, The Cooper Union, New York, N. Y. Department Laboratories open for inspection, 5:30 to 6:30 p.m. Dinner, 6:30 p.m., Nikolaus Chop House, 99 Second Ave. Contact Prof. W. A. Vopat. Phone: AL 4-6300.

Cornell University: Reunion, 8:00 p.m., Thursday, Nov. 30, 1950, Cornell Club, 107 E. 48th St., New York, N. Y. Contact W. M. Leonard, Cornell Club. Phone: PL 5-7210.

Georgia Institute of Technology: Dinner, 7:15 p.m., cocktails, 6:00 p.m., Columbia University Club, 4 West 43rd St., New York, N. Y. Contact Dudley W. King, 63 Wall St., New York, N. Y. Phone: WH 4-2590.

University of Illinois: Luncheon, 12:15 p.m., Thursday, Nov. 30, 1950, Governor Clinton Hotel. Contact F. O. Gaskill. Phone: MU 6-2346.

University of Michigan: Luncheon, 12:15 p.m., Thursday, Nov. 30, 1950, Engineers Club, 32 West 40th St., New York, N. Y. Contact E. G. Dudley, c/o General Electric Co., 570 Lexington Ave., New York, N. Y.

University of Missouri: Dinner, Thursday evening Nov. 30, 1950, Keen's Chop House, 72 West 36th St., New York, N. Y. Contact college reunion desk, ballroom foyer, Statler Hotel, for further details.

Northeastern University: Either a luncheon or dinner to be held, Thursday, Nov. 30, 1950. Contact college reunion desk, ballroom foyer, Statler Hotel, for further details.

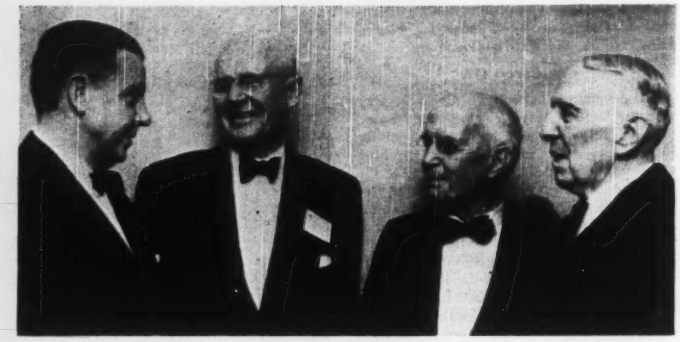
Oregon State College: Dinner, 6:30 p.m., Thursday evening, Nov. 30, 1950, East Room, Hotel Martinique, Broadway and 32nd St., New York, N. Y. Contact Prof. S. H. Graf, Oregon State College, Corvallis, Ore., or E. E. Parker, Turbine Divisions, General Electric Co., Schenectady, N. Y., or college reunion desk, ballroom foyer, Statler Hotel.

Purdue University: Reunion meeting, 6:30 p.m., Thursday, Nov. 30, 1950, Hotel Martinique, Broadway and 32nd St., New York, N. Y. A. A. Potter, dean of engineering, Purdue University, is guest speaker. Contact B. E. Sawyer. Phone: LO 4-3000.

Rensselaer Polytechnic Institute: Luncheon, 12:30 p.m., Thursday, Nov. 30, 1950. Contact I. M. Weinberg, New York Telephone Co., 140 West St., New York, N. Y. Phone: EX 4-4600, Ext. 2738.

Stevens Institute of Technology: Dinner, 6:30 p.m., Thursday, Nov. 30, 1950, Stevens Metropolitan Club, 106 West 56th St., New York, N. Y. Contact Harold R. Fee. Phone: RE 2-1742 or HOboken 3-0478.

Worcester Polytechnic Institute: Dinner, Thursday, Nov. 30, 1950. Contact R. Nims. Phone: MU 2-1500, or contact college reunion desk, ballroom foyer, Statler Hotel, for further details.



AT ASME FALL MEETING BANQUET

(*Left to right:* Dr. James R. Killian, principal speaker; John W. Higgins, general chairman of the meeting; George I. Rockwood, an ASME member for 59 years; and Prof. Carleton A. Read, a 57-year member of the Society.)

Women's Program

The Woman's Auxiliary of the Metropolitan Section has arranged an interesting program for women and guests attending the Annual Meeting. On Monday there will be the President's Luncheon and a tea dance later in the afternoon. On Tuesday, a trip has been planned to the United Nations at Lake Success, L. I. This will be limited to 80. On Wednesday the annual business meeting of the Woman's-Auxiliary will take place. Also on Wednesday the women will go to the Waldorf-Astoria for luncheon and a style show. In the evening there will be the Annual Banquet. On Thursday, a tour has been planned of the Williamsburgh Rooms of the Republican Club. This will be followed by a lecture by Mrs. Emily B. Hunter of F. Schumacher and Company, on "The Changing Scene in Decoration."

Industrial New England Scene of ASME Fall Meeting

Civic Responsibility and Selective Service Discussed

WORCESTER, Mass., a city primarily built on mechanical-engineering trades, was the scene of the 1950 Fall Meeting of The American Society of Mechanical Engineers. More than 500 mechanical engineers from all parts of the United States, some from Canada, and far-away India, were on hand for an excellent program of 24 technical sessions, 10 inspection trips pointing up Worcester's diversified industries, and many social events.

Advances in Textile Industry Discussed

Fifty-two papers covering a variety of technological material of interest to mechanical engineers were presented at 24 technical sessions. Appropriate to the New England locale, long noted for its textile industry, subjects covered the use of plastics in the textile industry, industrial application for nylon, plastics, textile-mill modernization, production costs of basic textile fabrics, selection and construction of worsted and woolen mills for low-cost operation, a description of a production machine for imparting and setting crimp in natural and artificial fibers, and the construction of modern cotton and rayon mills.

In the power field, experts discussed ultrasonic inspection of pipes, high-temperature high-pressure pipe joints, the trend of power-plant practice in Germany, modern boiler controls, problems of converting from coal to oil firing, the use of tungsten carbide in coal pulverizers, boiler-unit standardization, hot-process water softening, steam separation in boiler drums, the flow of a flashing mixture of water and steam through pipes and valves, and combined steam and gas-turbine processes.

A watch-mainspring dynamometer, design of nonlinear leaf springs, design of rotor-coil support rings, and machine-tool styling, were topics presented in machine design.

Other fields covered included management, rubber and plastics, heat transfer, education, production engineering, hydraulics, materials handling, wood technology, safety, and metals engineering.

An additional feature was the presentation of the Calvin W. Rice Lecture by Prof. Luigi Broglio who spoke on "The Method of Equivalence Applied to Engineering and to Mathematical Physics." Professor Broglio is a professor of theory in aeronautical structures at the University of Rome, Rome, Italy, and chief of the Aeronautical Department of Structures Air Ministry, Rome. At present he is a visiting professor at Purdue University, Lafayette, Ind. The Rice Lecture is named in honor of Calvin W. Rice who served as ASME secretary from 1906 to 1934, and whose work in the field of international relations did much to increase understanding between engineers of various countries.

Six of the papers presented are scheduled for publication in full or in condensed form in forthcoming issues of MECHANICAL ENGINEERING. In addition, digests of 25 of the ASME Fall Meeting technical papers appear in the ASME Technical Digest on pages 912-918 of this issue of MECHANICAL ENGINEERING. Pamphlet copies of these papers are available from ASME Order Department, 29 West 39th Street, New York, N. Y. Price is 25 cents per copy to ASME members.

Civic Responsibility Stressed

Nearly 160 ASME members, guests, and their wives, heard James D. Cunningham,

president ASME, emphasize the need for engineers to take an active part in things other than technological work. Speaking at the President's Luncheon on Tuesday, September 19, the first public social event of the Fall Meeting, he pointed out that engineering and technical-college faculties are awakening more and more to the need for humanizing the technical curriculum, and, what may be more significant, students themselves, in contrast to the attitude of just a few years ago, are welcoming and even demanding courses outside their chosen technical fields.

The reasoning behind these changes, he said, reflects the changing emphasis in our technical society—the awakening realization that technical knowledge is not enough.

If science has simply made man more comfortable, if it has made him stronger and sleeker, and even healthier, it has not improved him intrinsically at all, and we have done all that could be expected of us as human beings. But if science has released man from the demands of animal existence so that he may turn his energies toward moral and spiritual improvement, then the possibilities are as great as the accomplishments to date are small, and many of us have failed in our chief responsibility as citizens and human beings.

However, he indicated that there are a few hopeful signs. Increasingly, leaders of technical societies are turning away from their professional and business lives and accepting responsibilities in the education and welfare activities of the community. Increasingly too, technical leaders are assuming political responsibilities—and, he declared, it is in this area that our failure as citizens has been most shameful. Until we have done this and much more, how can we expect a political system based on the sovereignty of the people to work?

Mayor Andrew B. Holmstrom of Worcester, himself an engineer and a member of ASME, and honorary chairman of the Fall Meeting, welcomed ASME members and their guests to Worcester. Frank M. Gunby, vice-president of Region I, presided.

Civilian and Military Draft Urged

Drafting of all men of draft age if the present emergency becomes more acute and then assigning them to civilian as well as military duties, was advocated by James R. Killian, Jr., president of Massachusetts Institute of Technology, principal speaker at the ASME Fall Meeting banquet, held Wednesday evening, September 20.

At the present time, short of all-out war, said Dr. Killian, we should keep in college those young people who are competent to benefit from college, hold together the faculties necessary to teach them, and continue to maintain and strengthen our intellectual resources, "difficult as this may be."

The recently announced selective-service policy of deferring students above a certain standing in their classes after the freshman year is perhaps the best compromise now possible, and it was arrived at with the advanced counsel of a group of thoughtful and public-spirited citizens, Dr. Killian said.

Under a complete draft, the problem becomes, not one of deferment, but one of where

INSPECTING ASME PUBLICATIONS

(*Left to right:* James D. Cunningham, president ASME; Eric H. Smith, chairman of the technical-events program for the meeting; and Prof. Leslie J. Hooper, vice-chairman of the technical-events program.)

can a man best serve the country. Under such a plan a certain number of men should be required to continue their education in essential fields.

Dr. Killian said that the nation was in a "twilight period of emergency," a half light between peace and war which obscured the road ahead and dimmed the clarity of any policy or long-range plan.

It is like driving an automobile in the twilight, Dr. Killian said, the dim light makes it hard to see and the headlights are much less effective than they are in total darkness.

Dr. Killian emphasized that in our present emergency it is critically important that we do not disrupt our educational programs prematurely. As a nation we may be faced with an international explosion or with a series of Korean emergencies. If we prematurely disrupted or seriously curtailed our higher education, we could in the end wind up with a disastrous shortage of trained man power which would weaken us for either contingency.

You can't fight a modern war or maintain a modern peace without highly trained man power. You can't do either without first-rate scientists and engineers, he concluded.

As part of the banquet program over which Admiral Wat Tyler Cluverius, a member of the ASME and president of Worcester Polytechnic Institute, presided, four engineers were awarded the Fellow Grade in ASME. Honored were Neil P. Bailey of Rensselaer Polytechnic Institute, Troy, N. Y., John O. Amstuz, of the Behr-Manning Corporation, Troy, N. Y., Everett S. Lee, of the General Electric Company, Schenectady, N. Y., and Harry A. Winne, also of the General Electric Company in Schenectady. All were present except Mr. Winne, who will be awarded his certificate by the Schenectady Section. The citations were read by C. E. Davies, secretary ASME, and presented by ASME president, James D. Cunningham.

Admiral Cluverius paid tribute to the late Prof. Charles Metcalf Allen, director of W.P.I's Alden Hydraulic Laboratory, and cited Professor Allen's technical ability in the field of hydraulics and the high regard held for him by his students and friends. A minute of silence was observed in his memory.

"Engineer-Mayor" Andrew B. Holstrom, again was on hand to greet ASME members and guests, and told of the important contributions made by mechanical engineers to Worcester's industrial growth and strength. Following President Cunningham's civic responsibility theme, he also urged engineers to take greater interest in broad activities.

Wood Waste Discussed

How the New England Box Company solved its 1949 wood-waste problem was explained by Natham Tufts, vice-president and general manager of the company, during the Wood Industries Luncheon on Thursday, September 21. He pointed out that on the discard side of the 50,000,000 board feet of New England white pine in the rough lies the forest sawdust, slab, and slash pile—about 40 per cent by weight. On the useful side lies the prospect of 20 per cent waste—10,000,000 board-feet or 10,000 tons at two pounds to the foot, not counting the edgings never scaled or bought, but just the buttings, the shavings, the sawkerf dust, the jointing waste, and the outthrown knots, shake, cross-grain checks, and breakage. Of this about

AT WOOD INDUSTRIES LUNCHEON

(*Left to right:* Harry A. Pavitt, Charles R. Nichols, Jr., Roger R. Smith, Frank T. Parrish, and Robert A. Caughy, get together for a picture.)

JOHN W. HIGGINS (*extreme left*) TALKING OVER ASME PROGRAM WITH (*left to right*) M. W. GOKLANY, S. K. MUKHERJEE, N. K. CHOWDHURY, AND V. J. RAO, WHO REPRESENT THE GOVERNMENT OF INDIA AND ARE VISITING U. S. POWER-PLANT-EQUIPMENT MANUFACTURERS

$100,000 worth of waste is sold commercially at a 25 per cent profit. The company, he said, produces a cord of wood for every 15,000 board-feet, a ton of sawdust for each 3000 feet, a bale of shavings for every 300 feet. Then there are the chips that the hogs produce from edgings. The company burned 20,000 tons for which it received $140,000 worth of power at $7 a ton. Mr. Tufts' solution was therefore to burn that needed for power and develop a market to sell the remainder.

Some unsolved problems cited by Mr. Tufts were the following: Degrading from stain, worms, and borers; seasoning; inadequate waste-handling methods; matching shook plugs on a 45-deg angle; lower cost and better kiln drying; more Btu's from waste burned for power; and most important, grinding all wood at the point of growth and its reconstruction into lumber which shall be of equal strength, dimension fast, and free of imperfections.

Today, said Mr. Tufts, many different companies, institutions, and universities are pursuing wood-waste-utilization research in the wallboard field alone, independently, and non-collectively. Each hopes to succeed. All may fail through a lack of knowledge of the work of another firm. The answer, Mr. Tufts indicated, lies in the direction of collective effort. Fewer dollars would be wasted if the companies joined hands and put their dollars together—not just in the northeast but throughout the country.

Charles R. Nichols, Jr., Mem. ASME, Joseph Dixon Crucible Company, Jersey City, N. J., presided at the luncheon.

Worcester Industries Visited

Three simultaneous inspection trips took place on Tuesday afternoon, September 19, to Worcester Pressed Steel Company, and John W. Higgins Armory, Norton Company, and Heald Machine Company. At Worcester Pressed Steel the visitors toured the stamping shop and cold-rolled strip mill where they saw the operation of modern presses, welding, and annealing equipment used in present-day stampings. At the John W. Higgins Armory, which is a combined museum, library, and laboratory of pressed-steel products, the guests saw a display of both modern and ancient steel products.

ASME members and guests who visited the Norton Company saw the manufacture of grinding machinery and grinding wheels from the tunnel kiln for vitrifying the product through the finishing departments.

At the Heald Machine Company a group observed Heald machines in operation, boring and grinding a variety of parts. In the machine shops they inspected parts of machines being manufactured, assembled, and tested.

On Wednesday morning, September 20, inspection trips were made to the Crompton and Knowles Loom Works and General Electric Company, Fitchburg, Mass. In Crompton and Knowles' completely mechanized foundry, guests saw squeezer, light and heavy roll-over machines, and an automatic sand-conditioning and conveying system. Twenty looms of all types were inspected by the visitors.

The tour through General Electric began in the welding division and took the guests through the heavy-machinery section, the assembly and test areas, and the manufacturing area where the parts that make up welders, turbines, and superchargers were inspected.

The trips scheduled for Wednesday afternoon included the Bay State Adhesive Products Company, at Westboro, Mass., and the Telechron Company.

The tour through Bay State showed the visitors how grinding wheels are manufactured and handled, including hydraulic-press operations, balancing, and speed testing.

At Telechron the visitors inspected the automatic screw-machine, punch press, finishing, and hobbing departments. Of interest were the conveyer assembly lines in which motors, coils, and clocks are assembled in large-scale operations.

Two plants, Wyman-Gordon Company, North Grafton, Mass., and Reed-Prentice Corporation, were toured on Thursday morning, September 21. Visitors to Wyman-Gordon saw facilities for manufacturing, inspecting, and testing moderate-sized forgings of aluminum, steel, and other metals.

At Reed-Prentice, members and guests witnessed the manufacture of injection-molding machines in sizes ranging from 4 to 60-oz (plastic material) capacity. They also saw the production of zinc and aluminum die-casting machines.

On Thursday afternoon visitors to the Heywood-Wakefield Company, Gardner, Mass., saw production of modern and old colony furniture, Ashcraft furniture, high chairs, baby and doll carriages, school furniture, and railway-coach and bus seating.

Women's Program

The Women's Committee for this year's ASME Fall Meeting, headed by Mrs. Allen D. Wassall, arranged an attractive program for the three-day affair. On Tuesday there was a sight-seeing tour of the city and a visit to the Higgins Armory. At the Armory they were impressed with the vast steel collection which is housed in its own unique steel and glass building. Glass cases displayed various stamped, cold-forged, and deep-drawn steel parts for vehicles, radios, etc., as well as specimens of meteorites, iron ore, and raw steel. In the ancient wing the women viewed a group of sixteenth-century knights in armor, all in full steel panoply, and many other masterpieces of the armorer's art. Following the tour, tea was served at the Armory.

Committees

The following committees of the Worcester Section were responsible for the success of the meeting: *General:* John W. Higgins, chairman, R. H. Tolman, vice-chairman; *Honorary Chairman:* Andrew Holmstrom; *Technical Events:* Eric H. Smith, chairman, Leslie J. Hooper, vice-chairman, Earl C. Miller, John A. Holbrook, John M. Bartlett, Jr., Ronald G. MacIntyre, M. Lawrence Price, Robert S. Hahn, Ralph D. Abercrombie, Otto Maller, Frederick E. Bailey, Richard O. Palmer, Roger R. Smith, George Parmakian, Norman A. Wilson; *Inspection Trips:* Warren S. Snow, chairman, Ralph A. Huey, Lucian T. Allen; *Hotels, Registration, Information:* Carroll C. Tucker, chairman, Edward K. Allen, Jr., Umbert F. Corsini, R. L. Rougemont, Roger M. Scott, Harold K. Dows, Kenneth W. Fowler, Carl E. V. Rydman, Christopher Terpo; *Entertainment:* Philip R. Delphos, chairman, Ronald G. MacIntyre, John D. Kuppenheimer; *Printing and Signs:* Charles E. McMahon, chairman; *Publicity:* Roger N. Perry, Jr., chairman, Robert M. MacGregor, John T. Pierpont, Matthew Stepanski; *Reception:* Bradley C. Higgins, chairman, Wat Tyler Cluverius, F. Harold Daniels, Ralph F. Gow, J. Walter Gulliksen, Frederick J. Riker, Albert Palmer; *Finance:* George W. Motherwell, chairman, Philip A. Nims, vice-chairman, Harold W. Gates; *Ladies' Events:* Mrs. Allen D. Wassall, chairman, Mrs. George W. Motherwell, Mrs. Bradley C. Higgins, Mrs. John W. Higgins, Mrs. Robert Hahn, Mrs. Eric Smith, Mrs. Roger N. Perry, Jr.

Petroleum Mechanical Engineering Conference Widely Supported

New Orleans Becoming Major Oil Center

THE growing importance of New Orleans as a center of the petroleum industry and the gratifying manner in which mechanical engineers of that industry were participating in the activities of the Petroleum Division of The American Society of Mechanical Engineers were two of the dominating impressions carried away by more than 400 petroleum engineers and executives who attended the 1950 Petroleum Mechanical Engineering Conference at the Roosevelt Hotel, New Orleans, La., Sept. 24-28, 1950.

The program of 36 technical sessions on the general theme of cost reduction attracted industry-wide attention. Some companies sent as many as 20 members of their technical staff to participate in the discussions. A sizable delegation attended the conference from New York and California. Technical sessions discussing the current problems of the industry attracted the largest audiences. The following problems, as indicated by the heavy attendance at the sessions where they were discussed, were among those of paramount importance to the industry: (1) Allowable load on unsupported casing columns; (2) refinery lubrication as a management problem; (3) gaskets in the oil industry; (4) maintenance and lubrication of pipe-line engines and compressors; (5) crankcase explosions; and (6) latest practices in offshore drilling.

For convenience of members, the program was divided into three parts—production, refining, and transportation. Five technical sessions were held under each of these headings, the sessions of each series running concurrently.

New Orleans as a Petroleum Center

Official opening of the conference was a welcome luncheon at which The Hon. deLesseps S. Morrison welcomed members and guests to New Orleans. As more and more oil companies shifted their operational headquarters to New Orleans, Mr. Morrison said, the City was rapidly becoming one of the nation's important oil centers.

New oil fields and producing areas have been moving, in a decidedly southeast direction, to New Orleans from other sections, he said. Oil exploration and discovery in Louisiana, Mississippi, Alabama, and Florida, along with offshore drilling, were contributing to the growing importance of the city as an oil-producing center.

New Orleans, Mayor Morrison said, was vitally interested in the present tideland discussion, a dispute which has curtailed offshore operations considerably. The people of New Orleans, he said, believe that the oil industry will be better served if offshore producing areas were to remain under the supervision of each state.

As a gesture of hospitality, Mayor Morrison conferred upon Carl J. Eckhardt, vice-president, ASME Region VIII, a certificate of honorary citizenship and presented him with the key to the city.

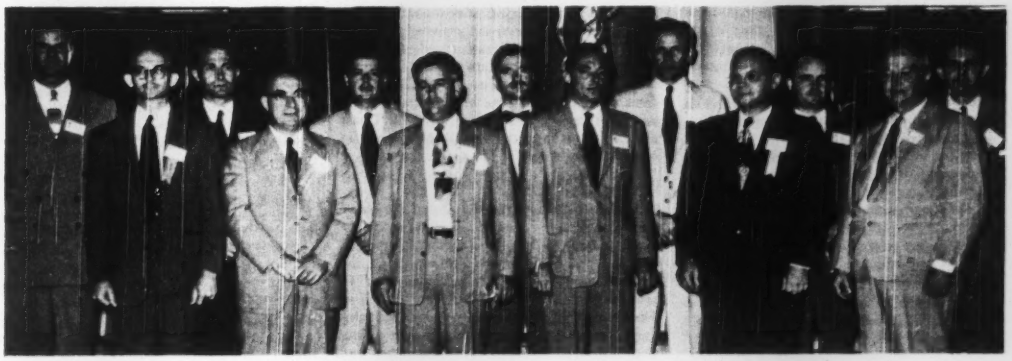
Foundation of American Economy

The foundation of American economy was low operating costs in industrial production made possible by the production of large volumes of high-quality goods, according to H. J. Voorhies, general manager, Esso Standard Oil Company, Baton Rouge, La. Mr. Voorhies was the main speaker at the welcoming luncheon.

Both the producer and the consumer gain, he said, when automobiles, radios, refrigerators, and gasoline are made available in large volumes at low cost. No one gains when productivity is low—when costs are high. High productivity is obtained in a number of ways: Through inventions and new techniques which economize on effort; through effective employee-employer relations which result in teamwork; under a favorable political climate which encourages investment. One of the most important means available to increase productivity is through cost reduction.

H. J. VOORHIES ADDRESSING THE WELCOMING LUNCHEON OF THE PETROLEUM MECHANICAL ENGINEERING CONFERENCE, NEW ORLEANS, LA., SEPT. 24-28, 1950

Describing his company's program to increase productivity by the adoption of cost-reduction measures, Mr. Voorhies said that a vital feature of the program was employee training, classroom work, and on-the-job training activities for wage earners, and a system of job rotation for supervisors. He said this



MEMBERS OF THE NEW ORLEANS COMMITTEE WHICH MADE ARRANGEMENTS FOR THE PETROLEUM MECHANICAL ENGINEERING CONFERENCE, NEW ORLEANS, LA., SEPT. 24-28

(*Left to right:* Robert P. Lockett, Jr., Waldemar Nelson, Allen H. Jensen, David Moodie, Walter Verlander, Allen W. Betz, G. Cary Carpenter, Robert L. Nall, C. S. Pugsley, Jr., Frances B. Blackstone, M. P. Watson, James M. Todd, C. R. Draughon, Jr.)

has improved self-confidence and morale of the employees, and the job-rotation program for supervisors has resulted in better teamwork and given more enthusiasm for their jobs to many of the men.

The Petroleum Industry

The high light of the conference was the banquet on Tuesday, Sept. 26, at which Bruce K. Brown, president, The Pan-Am Southern Corporation, New Orleans, La., as main speaker, reviewed how peace and war had affected the petroleum industry in the past decade.

At the outbreak of World War II, a few companies were producing 40,000 barrels per day of high-octane aviation gasoline by almost untried processes. By the end of the war the industry was producing 600,000 barrels per day and every refinery of any size was participating in the aviation-gasoline program. Of the billion dollars spent on special facilities, oil companies carried over 80 per cent of the expenditure.

Another fact illustrating the stupendous contribution of the industry, according to Mr. Brown, was that over 60 per cent of the deadweight tonnage that had to be shipped overseas to win the war was petroleum. Of this, 50 per cent was aviation gasoline.

Civilian demand for petroleum production during the postwar years has increased 50 per cent, Mr. Brown said, adding that our resources in crude underground and refining capacity have also increased substantially. In case of full-scale mobilization, he said, there was no reason why the civilian population should suffer a petroleum shortage even though the new jet planes were greater "fuel eaters" than the old piston-engine kind.

Mr. Brown reported that the industry was having difficulty in supplying aviation gasoline for the Korean effort even though current demand for aviation gasoline was much smaller than the demand during World War II. The situation has perplexed military and government leaders and many oil men, particularly those who were not refiners or technologists by profession. The reason for this situation was due to technological progress, he explained. Military aviation gasoline used in many World War II planes was no longer good enough for many of the military planes in use today. The high-octane aviation gasoline was manufactured by adding a synthetic petroleum chemical called "alkylate" to regular gasoline.

The old aviation fuel required 35 pe rcent of alkylate in combination with other ingredients but today's gasoline, Mr. Brown said, required 85 per cent or more of the precious alkylate. The amount of alkylate produced by the nation was a key to the amount of aviation gasoline that could be produced. Mr. Brown explained that the reason why the industry was having difficulty in meeting the meager demands of the current struggle was because industrial capacity for production of alkylate had not kept pace with the increasing demand for the product caused by powerful fighting machines.

The industry, however, has the resources to provide aviation gasoline for a full-scale war, he concluded.

CARL J. ECKHARDT (*right*) VICE-PRESIDENT, ASME REGION VIII, PRESENTING LARIAT AND BRANDING IRON, SYMBOLIC OF THE STATE OF TEXAS, TO MAYOR DELESSEPS S. MORRISON AT THE OPENING LUNCHEON OF THE PETROLEUM MECHANICAL ENGINEERING CONFERENCE

Hurricane-Design Data

Engineers designing structures for service on the Gulf Coast must make allowance for the hurricane forces capable of releasing energy over its destructive radius at the rate of approximately $2^1/_2$ atomic bombs per second. This estimate of hurricane power was made by A. H. Glenn of New Orleans, consulting engineer, during the Tuesday session on oceanography.

Hurricane gusts, Mr. Glenn said, have a maximum velocity of about 50 per cent greater than the sustained winds measured over intervals of several minutes. The maximum gusts in the vicinity of 185 miles per hour have been recorded in hurricanes.

The hurricane-design data now available is a great improvement over the guesswork of earlier years but, Mr. Glenn added, there are serious gaps in existing data and the continued industrial expansion on the Gulf Coast will demand that these gaps be eliminated. He said that co-operative effort by Gulf Coast industry to acquire the necessary design data would achieve results in about ten years.

Offshore Operations

At the Friday morning session of the transportation program, A. F. T. Seale, Kerr-McGee Oil Industries, Oklahoma City, Okla., reported that oil and gas beneath the waters of the Gulf of Mexico probably extended over an area of at least 75 miles from the coastline. The tapping of these deposits, however, introduced hazards of operation which were greater than those encountered in the marshes and much greater than problems on dry land, Mr. Seale said. Hurricanes, fogs, and corrosion contributed to the difficulties of offshore drilling operations.

Aside from the fact that the Gulf area is submerged, there is no difference in the type, magnitude, and structural habits of similar areas in the Gulf and those on land. Wells have been drilled and production found at depths ranging from 1600 ft to more than 14,000 ft. So far eight oil fields and 11 gas fields have been discovered in the Gulf Coast waters of Louisiana.

The Search For Oil

E. W. Jacobson, chairman, ASME Petroleum Division, commenting on the constant search for oil, said that offshore prospecting was still in early stages and that petroleum companies would continue such operations despite the legal question of ownership. Mr. Jacobson said that it has been established without doubt that there were tremendous deposits off the Gulf Coast. The problem, however, he said, was to develop and design new equipment at cheaper cost to make further explorations profitable. Mr. Jacobson, who was responsible for the design of the 10-foot wheel "marsh buggy" used in Louisiana and Texas swamps for oil prospecting, said that storms and hurricanes were the major problems of offshore drilling. Another problem was the corrosive effect of sea water.

300 Attend IIRD Conference

THE Fifth Annual Conference of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers was held in Buffalo, N. Y., Sept. 18-19, 1950, in conjunction with the exhibit and conference of the Instrument Society of America. Some 300 ASME members and guests attended. The ASME part in the program was four sessions which consisted of papers on steel-plant instrumentation and a panel discussion on deduction. At the IIRD Luncheon sponsored jointly with the AIEE, C. C. Furnas, director, Cornell Aeronautical Laboratory, discussed "The Economics of Development of Research Projects."

George C. Crewson, who was toastmaster, received his gold membership card in recognition of 35 years of membership.

ASME Calendar of Coming Events

Nov. 25-Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers was Aug. 1, 1950)

April 2-5, 1951
ASME Spring Meeting, Hotel Atlanta-Biltmore, Atlanta, Ga.
(Final date for submitting papers—Dec. 1, 1950)

April 16-18, 1951
ASME, Region VIII, Annual Meeting, Hotel President, Kansas City, Mo.

April 17-19, 1951
ASME Process Industries Conference, Baltimore Md.
(Final date for submitting papers—Dec. 1, 1950)

June 11-15, 1951
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(Final date for submitting papers—Feb. 1, 1951)
(For Meetings of Other Societies see page 935)

Codes and Standards a Tremendous ASME Operation

HOW The American Society of Mechanical Engineers serves the engineering profession through its codes and standards activities was reviewed at an informal meeting of the ASME Council and Board on Codes and Standards during the 1950 Fall Meeting in Worcester, Mass.

F. S. Blackall, jr., chairman of the Board, explained that the Board, acting on authority delegated to it annually by Council, supervises ASME activities in the fields of standardization, industrial safety, codes for boiler and pressure-vessel construction, and power test codes. Reporting to the Board, either directly or through the four standing committees, he said, were 350 committees and subcommittees. The Board also supervised the work of six committees, sponsored jointly with other organizations and 77 ASME representatives on committees sponsored by other engineering organizations.

L. W. Kattelle, senior representative of the Society on the ASA Standards Council, said that ASME was participating through the ASA in four ISO projects; screw threads, boiler code, limits and fits, and graphical symbols.

Standards Activities

P. V. Miller of the ASME Standardization Committee told the Council that ASME is shouldering full reponsibility for processing and expediting work of 24 sectional committees under the American Standards Association procedures and three special ASME Committees. More than 1100 individual engineers, he said, were contributing to the ASME standards program. During the past year these engineers revised or produced 496 pages of new standards.

The ASME concerns itself with dimensional standards and leaves to the American Society for Testing Materials the question of standardization of materials specification. This division of responsibility was also applied to the ASME Boiler Construction Code, he said.

Questioned by Pres. James D. Cunningham about the unified screw-thread standard formally accepted by the United States, Great Britain, and Canada in 1948, Mr. Miller stated that the new threads were being well received and estimated that 75 per cent of new production in the United States was in accordance with the unified standards.

Safety Committee

Although the Safety Committee reports to the Board on Codes and Standards, its activities are much broader than the formulation of codes and standards, according to J. V. Grimaldi, chairman, Safety Committee. The Committee, he said, sponsored technical sessions at national meetings, was engaged in developing a program for integrating safety education into existing engineering curricula, and was promoting participation of the Professional Divisions and Sections in safety work. Because of its general activities, Mr. Grimaldi suggested, the Safety Committee would be more effective if reconstituted as a Board on Safety.

A national revival of interest in safety has prompted Congress to write bills which are trying to establish a government agency to write and enforce safety standards. The Committee's view, however, is that safety is everybody's business. It should have the support of agencies such as the ASME.

Boiler Code Committee

F. S. G. Williams, member ASME Boiler Code Committee, reviewed for Council the history and present status of his committee's activities. The committee, he said, was first organized in 1911, and published the first Boiler Construction Code, a document of 174 pages, in 1914. Since 1914, the Code has been expanded into nine sections totaling 1377 pages.

The Boiler Code Committee, he said, consisted of some 22 to 24 men representing producers, users, inspectors, insurance-company representatives, consultants, and metallurgists. It met six to eight times a year to review the work of its subcommittees, to make decisions concerning policy, and to recommend revisions to and interpretations of the Code, he explained. The Boiler Code Committee makes no attempt to enforce the Code. Rather, it endeavors to keep the Code up to date in line with constantly changing practice and minimum requirements for safety. When the Code is adopted as law, it becomes the job of inspectors—state, municipal, and insurance company—to see to it that the Code is enforced. The Code has been incorporated into the laws of 38 states, the nine provinces of Canada, and the territories of Hawaii, Puerto Rico, and the Panama Canal Zone.

Through the efforts of the American Uniform Boiler Law Society the ASME Boiler Code was finding its way into the practices of countries in all parts of the world, Mr. Williams said. Sixteen countries in Europe, Central and South America, and the Pacific were using the Code with minor changes. Three other countries have the Code under consideration.

The Committee itself assumed international responsibility with acceptances of the secretariat of the International Standardization Organization Technical Committee on the Unification of Boiler Construction Codes. Although the task would be a long and difficult one, Mr. Williams said; it was accepted by the Committee because it was recognized that the American engineering profession must accept responsibility for furthering this international development.

Power Test Codes

Speaking for the Power Test Code Committee, G. A. Orrok, Jr. told the Council that while the Committee had issued no new power test codes this year, it has under preparation many needed revisions to old codes and was working on a number of new ones to be completed shortly. The Committee was responsible, he said, for the standardization projects on prime movers of the International Electrotechnical Commission which has been made the electrical branch of the ISO. The Power Test Code Committee has recently recommended active participation by the ASME in two ISO projects relating to measurement of fluid flow and pump testing.

New ASME Officers Elected by Letter Ballot

AS reported by the tellers of election, 1951, W. H. Larkin, G. J. Nicastro, and J. M. Talbot, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 26, 1950. The total number of ballots cast were 10,113; of these 139 were thrown out as defective.

	Votes For	*Votes Against*
For President		
J. Calvin Brown	9927	47
For Regional Vice-Presidents—serve 2 years		
Harry R. Kessler	9950	24
Stephen D. Moxley	9953	21
John T. Rettaliata	9944	30
Carl J. Eckhardt	9948	26
For Directors at Large—serve 4 years		
Lionel J. Cucullu	9956	18
Harold E. Martin	9953	21

The new officers will be introduced and installed in office during the 1950 Annual Meeting of the Society to be held at the Statler Hotel, New York, N. Y., Nov. 26-Dec. 1, 1950.

Biographical sketches of the newly elected officers were published in the August, 1950, issue of MECHANICAL ENGINEERING, pages 683-686.

Heat Transfer and Fluid Mechanics Institute

PLANS are well under way for the fourth meeting of the Heat Transfer and Fluid Mechanics Institute to be held at Stanford University, Stanford University, Calif., June 20-21, 1950.

The Institute was organized in 1948 by five California engineering schools with the aid of West Coast Sections of national engineering societies. Its purpose is to provide for West Coast engineers an annual meeting of sufficient breadth and quality to make a definite contribution to engineering knowledge. The Institute has helped to reduce the effect of geographical isolation of engineers and scientists by giving them an opportunity to keep in touch with latest advances in heat transfer and fluid mechanics by attending a local event. The policy of the Institute is to encourage participation on a nationwide basis.

For the 1951 program, arrangements are being made for papers of the following subjects: Thermal radiation, conduction, convection, mass transfer, combustion, compressible and incompressible flow, and various

aspects of channel and boundary-layer flow behavior.

The 1948 Institute papers were not preprinted, but many of them appeared later in various technical publications. In 1949 The American Society of Mechanical Engineers undertook publication of the Institute papers in the form of a transactions. For the 1950 meeting abstracts of the papers were printed by the University of California Extension Division.

The general excellence of the papers and the good attendance at each of the Institute meetings has demonstrated that the Institute is serving needs of engineers and research workers in the West Coast area. For the 1951 meeting the Institute is again seeking the aid of the engineering societies interested in heat transfer and fluid mechanics. According to A. L. London, Mem. ASME, and chairman of the 1951 Institute, sponsorship, publicity in official journals, financial support, and publication of Institute papers are forms of support being sought.

Junior Forum

New England Juniors Hold Successful P.D. Conference During Fall Meeting

JUNIOR members of the New England Sections of The American Society of Mechanical Engineers held a successful conference on "How Is Your P.D.?" (professional development) at the 1950 ASME Fall Meeting held at Worcester, Mass., Sept. 16–21, 1950. F. Everett Reed, member, National Junior Committee, was chairman.

Some 150 student members, juniors, and older members of the Society took part in the conference which lasted well into the evening. Following a talk on professional development by William T. Alexander, dean, College of Engineering, Northeastern University, Boston, Mass., and comment from each of the ten junior delegates representing the Sections of Region I, the meeting was given over to an informal exchange of opinion and questions on how a young engineer could best attain full professional standing.

The conference was the third of a series made possible by the generous aid of the Old Guard Committee which paid the traveling expenses of each of the Junior delegates.

Region I junior delegates were: *Boston Section*, Robert B. Green; *Bridgeport Section*, John Bodnar; *Green Mountain Section*, Clinton A. Renfrew, Northfield, Vt.; *Hartford*, Miss Hope Wohnus; *New Haven Section*, John J. Martin, Jr.; *New London Section*, Milton W. Davis; *Providence Section*, T. Campbell McGreen; *Waterbury Section*, Paul Ryder; *Western Massachusetts Section*, William S. Mabb, Agawam, Mass.; and *Worcester Section*, Ralph A. Huey.

Hallmarks of a Profession

Technical competence and a service motive to the community and society were the two hallmarks of a profession, according to Dean Alexander. The engineer must assume civic responsibility: he must not be content to remain anonymous, submerged in his technical work.

Dean Alexander warned that some in the audience might be young enough and misguided enough to think that the amount of personal income was an index of success. There was no premium in engineering in terms of financial return. If a man's primary interest was income, he should adopt the tactics of the skilled or semiskilled trades. There was no correlation between happiness and amount of income, for mere possession of money did not insure happiness. The older a man got, he continued, the more he was convinced that the one who was happy in his job was the one who had achieved success. To be truly happy in one's work, there must be attached to it a notion of doing something worth-while for society. One of the fundamental reasons why engineers must act like and become professional was to achieve happiness and to get the greatest amount of satisfaction from their work.

Referring to unionization of engineers, Dean Alexander said he was disturbed by the tenor of literature prepared by groups organized under provisions of the Wagner and Taft-Hartley Acts. Since by its nature a union was a pressure group, it was difficult if not impossible for a union to operate as a professional organization. It was the responsibility of older engineers to see that initiative and effort of young engineers was recognized and rewarded by management.

While registration was good from an educational point of view, Dean Alexander said he saw no correlation between licensure and public recognition of engineers. Public regard could be achieved only through the efforts of engineers, he stated.

Attitude was the big thing in professional development. Dean Alexander listed the following attitudes which he said might be characterized as "intelligent selfishness."

1 Always consider the interest of the company by whom you are employed as paramount. If you stand out a little bit in a favorable sense from the group with which you are working, you should be on the way to promotion. Remember that there is more room for good men at the top than mediocre men on the bottom.

2 Do not tell the boss off when you leave a job. You never know when you may need his recommendation.

3 It is well to learn how to face disappointment in stride and without bitterness.

4 Be willing to undertake trivial tasks in the early stages of your career. Do every job as though it were the most important one you ever had.

5 Remember that the company employing you does not consider important the amount of money which you consider necessary for you to live in the manner in which you think you should.

AT THE FALL MEETING P.D. CONGERENCE
(*Left to right:* R. Nelsen, Jun. Mem., F. Everett Reed, chairman, and William T. Alexander, dean, College of Engineering, Northwestern University, Boston, Mass.)

Dean Alexander concluded with a comment on personal security which, he said, if too ardently sought leads to mediocrity.

Junior Delegates Speak

Clinton A. Renfrew, Green Mountain Section, led off by asking whether the analogy of engineering and medicine was a clear one inasmuch as doctors deal with the public in a more direct sense than engineers. Dean Alexander accepted the fact of differences in this respect and added that when a doctor is chosen by a patient the former must have qualifications set forth and recognized by the public. On the other hand, the public rarely deals with an individual engineer.

John Bodnar, Fairfield County Section, raised the question of participation in society affairs by some of the more prominent engineers now in responsible positions. He pointed out that teachers held out to students the idea that ASME was a means of meeting prominent engineers, but there existed a serious problem of getting those influential members out to local section meetings. Dean Alexander commented that the problem was by no means "one way" and that in some Sections it was difficult to obtain the support of young engineers. Lester Bosch, Boston Section, reported that there is a difference of opinion in the Executive Committee of the Boston Section as to the best way in which to get older and younger members to meet effectively. He felt it inadvisable to think of young members as a special group of engineers needing special treatment.

T. Campbell McGreen, Providence Section, expressed gratitude to the Old Guard for making the meeting possible and commented that any young member making himself available for Society committee work would find plenty to do.

John J. Martin, New Haven Section, also mentioned the difficulty of obtaining active

participation by older members and asked George I. Rockwood, as a man of experience, what a Section can do to get these persons to attend Section activities.

Qualities of an Engineer

Mr. Rockwood, a member of ASME since 1891, who is still active as chairman of the board of trustees of Worcester Polytechnic Institute, related experiences of his early years in the ASME, which then numbered only 150 engineers, the greater number of whom attended each Annual Meeting. He recalled Messrs. Babcock and Wilcox, founders of the company bearing their names, as imposing personalities, and characterized Robert Thurston, as a man of dignity who did not wish to be contradicted on any subject. Mr. Rockwood set forth these desirable qualities for an engineer:

1 One of the fundamental qualities of an engineer is that he should be a gentleman.

2 He should be possessed of an ideology in which everything should be better than it is, from himself to it.

3 The engineer should have a real command of the English language in order to be able to write effective reports.

4 The engineer should enlarge the sphere of his interests.

5 He should be bigger than his job.

6 The engineer must learn to understand other people and be able to give a pretty good guess as to how they are going to react.

7 By contrast to the shopman whose interest is glued to what was or has already been done, the engineer must know what to do next.

8 The engineer should be loyal to his employers; practice of Christian principles is the basis for business success.

Paul Ryder, Waterbury Section, commented that the young engineer in a subordinate position must be willing to assume responsibility and take charge of details. He also cited the desirability of having an objective in mind in whatever may be undertaken.

Milton W. Davis New London Section, asked how employers feel about allowing time off for engineers to engage in civic affairs. President James D. Cunningham replied that there were many evening hours for such activity. These also happen to be the hours when much of this work was normally carried on. Mr. Cunningham also urged the spending of time in church work. He added, however, that, as an employer, if his men ask for occasional time off to be spent for a good purpose in the civic interest, he would be glad to cooperate.

Commenting on the problem of getting active participation by influential older members of ASME, President Cunningham suggested that if personal invitation was extended such individuals, a response would surely follow. Mr. McGreen, Providence Section, reported that each member or the executive committee of his Section contacted other members by telephone prior to meetings and that this tactic had improved attendance. Mr. Bodnar, Fairfield County, (Bridgeport), expressed the opinion that there was a wide gap that must be bridged between management and active young ASME members.

Miss Hope Wohnus, Hartford Section, asked about what attitudes might be assumed in facing disappointments in large organizations. Dean Alexander replied by asking recognition of the fact that there were some groups in which promotion is a result of family ties or other influence not directly connected with ability. A person who was lucky enough to get a job must still be able to produce enough to hold it.

Ralph A. Huey, Worcester Section, wondered whether ASME planned to do anything to insure recognition of engineers in the armed forces. C. E. Davies, secretary ASME, asserted that the Society recognizes the seriousness of the problem of the most effective use of engineering man power, both in industry and the armed forces. He reported that the National Security Resources Board had requested the Engineers Joint Council and a comparable organization among scientists on Sept. 6, 1950, to develop a policy for the effective utilization of engineers during the emergency. The EJC intends to set up an Engineers Man Power Commission of 18 members, including representatives of the American Society for Engineering Education, under the chairmanship of E. G. Bailey, past-president ASME. (See page 930 of this issue.) This commission was to report back to the NSRB within 90 days on a policy for engineering man-power utilization, Mr. Davies said.

An engineer from Fairfield County Section reported on a meeting scheduled for October 18, to which the ASME Section has invited the doctors and lawyers of Bridgeport as a step toward professional standing.

Miss Wohnus at this time pointed out the value of "A Professional Guide for Junior Engineers," and the personal appraisal form developed by the Engineers' Council for Professional Development.

The students from Worcester Polytechnic Institute had questions to ask. The first concerned the proper attitudes of young engineers toward employers. A second question concerned the difficulties in receiving positions observed by young men connected with the military reserves. Colonel Davies again pointed out efforts of the ASME in this situation and held out hope for a satisfactory solution although, because of its complexity, not in the near future.

Reported by F. EVERETT REED, member, National Junior Committee

Actions of the ASME Executive Committee

At a Meeting at Worcester, Mass., Sept. 20, 1950

A MEETING of the Executive Committee of the Council was held at the Sheraton Hotel, Worcester, Mass., Sept. 20, 1950. There were present: James D. Cunningham, chairman; Forrest Nagler, vice-chairman; F. S. Blackall, jr., A. C. Pasini, of the Executive Committee; E. G. Bailey, past-president; A. R. Mumford, vice-president; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Seventy-Year Membership Certificate

A special certificate for Henry Marx, president, G. A. Gray Company, Cincinnati, Ohio, commemorating his 70 years as an ASME member, was approved. Mr. Marx is the oldest member in years of membership.

Applied Mechanics Reviews

Publication of the *Applied Mechanics Reviews* for two more years was approved on the assurance that every effort would be made to reduce the financial burden being carried by the Society. This decision will be subject to a review in September, 1951.

Welding Research Council

Upon recommendation of the Board on Codes and Standards, payment of a sum of money was authorized from the Development Fund as the Society's contribution to the work of the Pressure Vessel Research Committee of the Welding Research Council.

1950 Awards

The following awards recommended by the Board on Honors were approved:

Melville Medal Award: to Samuel Jasper Loring, consulting engineer, Hamilton Standard Propeller Division, United Aircraft Corporation, East Hartford, Conn., for his paper, "A Theory of the Mechanical Properties of Hot Plastics."

Charles T. Main Award: to Richard T. Johnson, University of Detroit, Detroit, Mich., for his paper "The Need for Conversion to a Five-Year Course in Engineering Instruction for the Bachelors Degree in Order to Include Additional Instruction in the Humanities, and in Public Relations."

Undergraduate Student Award: to James Norris Colebrook, University of Cincinnati, Cincinnati, Ohio., for his paper "Design and Construction of a Pressure Transducer Testing Machine."

ECPD Postcollege Program

Following a review of the postcollege training program developed by the ECPD Committee on Professional Training, the Committee voted ASME approval of the program.

Research Committee

A committee consisting of R. A. Sherman, E. G. Bailey, and John Magos was appointed to review ASME policy with respect to financing the Society's research activities.

Battelle Memorial Institute

Extension of the agreement by the ASME and Battelle Memorial Institute covering a project relating to high-temperature data on stainless steels was approved.

Calvin W. Rice Lecturer

Dr. Luigi Broglio of the University of Rome,

Italy, was named the Calvin W. Rice Lecturer for 1950. His lecture, "The Method of Equivalence Applied to Engineering and to Mathematical Physics," was delivered at the 1950 Fall Meeting.

Resolution of Thanks

A resolution was adopted expressing the thanks of the Society to all who contributed to the success of the 1950 Semi-Annual Meeting in St. Louis, Mo.

Sections

After considering actions by the Akron-Canton and Youngstown Sections whereby individuals were made affiliates of the Section for a payment of a $3 fee, the Committee agreed that the practice should be discontinued and that in the case of the two Sections mentioned a period of two years be granted to carry out affiliate obligations already undertaken.

Student Branches

Authorization was granted for the formation of ASME student branches at the University of Massachusetts, Amherst, Mass., contingent upon accrediting by the ECPD, and at the Colorado School of Mines, Golden, Colo.

Nonaccredited Schools

Upon recommendation of the vice-presidents, the policy on nonaccredited schools approved in June, 1947, was accepted for an additional three years. This policy directs that Sections in the vicinity of nonaccredited engineering schools be encouraged to establish close relations with the students of those schools and that a sum to cover expenses be granted to co-operating Sections. The schools should be in the process of being accredited by the ECPD.

Certificates of Award

Certificates of award for the following retiring chairmen were approved: Herbert H. Hall, Pittsburgh Section, Louis G. Smith, Baltimore Section, C. F. Kayan, Process Industries Division.

EIC-ASME Joint Conference Committee

Upon recommendation of the Joint Conference Committee, it was voted to approve: (1) The attendance of student members of EIC attending ASME meetings in Canada or the United States under the privileges enjoyed by ordinary members for such meetings; (2) adoption of the list of Canadian schools where EIC has student members (in addition to Toronto, Queens, and British Columbia) as part of the ASME list of approved schools; (3) consideration for Junior membership, according to the standard procedures of ASME, of EIC students graduating from Canadian universities where mechanical engineering is taught.

Definitions of Engineering Specialties

In connection with the Survey of Selected Engineering Personnel conducted by the Society, for the Engineers Joint Council, a Committee consisting of Crosby Field, J. Keith Louden, H. B. Maynard, Erik Oberg, J. K. Salisbury, R. A. Sherman, and A. C. Stutson was designated to aid in the preparation of definitions of various specialities within the field of the ASME.

American Institute of Architects

S. Logan Kerr was named ASME representative to serve on a committee of the American Institute of Architects whose objective is to co-ordinate the services of people engaged in large-scale construction and design and to propose collaboration among them.

Charles M. Allen

The death of Charles M. Allen, honorary member of the Society, on Aug. 5, 1950, was noted with regret.

Appointments

The appointments on the boards, committees, and joint activities recommended by the Organizations Committee were approved.

The following presidential appointments were confirmed: Neil H. Brown as honorary vice-president for inauguration of president, Consolidated University of North Carolina; Paul W. Thompson as honorary vice-president for inauguration of president and fiftieth anniversary, Carnegie Institute of Technology.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York, 8 West 40th St.
Chicago, 84 East Randolph Street
Detroit, 100 Farnsworth Ave.
San Francisco, 57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, registered, 34, married. Experienced industrial purchasing and design and development of optical machinery. Now employed. Desires change with opportunities to broaden experience, particularly in production engineering. Me-779.

MECHANICAL ENGINEER, industrial engineering electives, 24, June, 1950, graduate Clarkson College, veteran, top sixth of class. Desires opportunity in refrigeration and/or air conditioning as assistant for consulting, estimating, or production and planning engineer. Me-780.

PRODUCTION ENGINEER, 27, married, BAME, BSIE, with honors. Navy chief engineer. Three years' experience production, scheduling, systems. Presently employed. Prefers production or industrial-engineering position, N. J. Me-781.

INDUSTRIAL ENGINEER, 41, BSME degree. Ten years' experience with manufacturer of small precision instruments, in charge of process planning, special tooling, and development of new products. Me-782.

MECHANICAL-METALLURGICAL ENGINEER, BME, MS, 27, single, four years' experience design, development, stress analysis, and physical testing. Two years college teaching. Desires responsible position in vicinity of New York, N. Y. Me-783.

MECHANICAL ENGINEER, 24, BSME, 1½ years' experience designing auxiliary production equipment and general engineering work. Desires production engineering or development with medium-sized, high-production company. Me-784.

POWER-PLANT ENGINEER, 39, married, BSME, 12 years' experience supervision power-plant maintenance, operation, and betterment. Electric welder, three years. Me-785.

INDUSTRIAL AND MECHANICAL ENGINEER, graduate, 23. Graduate work completed June, 1950, University of Michigan. Two years' military government experience. Fluent French, German, Czech, some Spanish. Locate anywhere. Me-786.

RECENT GRADUATE, 28, single, veteran, BSME, 1950, University of Connecticut, Tau Beta Pi, Pi Tau Sigma, seeks trainee or junior-engineering position with future. New England, N. Y., N. J. Me-787.

MECHANICAL-ENGINEERING GRADUATE, BME, 33, desires position as junior draftsman with firm building heavy machinery. Have one year's drafting experience, also mechanical inspection experience. Me-788.

MECHANICAL ENGINEER, 15 years' experience design, development, and research, portable-electric-tool industry; engineering supervision and shop management; desires permanent connection with progressive and well-established manufacturer. Me-789.

MECHANICAL ENGINEER, BSME, June, 1949, veteran, 24, single. Desires junior engineering position with small or medium-size manufacturing concern, New York and vicinity. Presently employed. Me-790.

MECHANICAL ENGINEER, 26, BME, married, employed, 19 months' experience, including machine design, production engineering, plant maintenance. Prefers position in machine-design work. Will relocate. Me-791.

DEVELOPMENT OR ADMINISTRATIVE ENGINEER, 28, single, BSCE, MSME, registered. Eight years' experience, consisting of wharf construction, oil-refinery pump and piping design, instructor in hydraulics, research-project engineer. Good organizer, can write reports. European location preferred. Me-792-509-D-4.

TECHNICAL EDITOR, 28, single, presently employed on nationally known horizontal technical magazine, available immediately. Prefers house organ or vertical publication. Will also consider technical-advertising, copywriting or public-relations position. Me-793.

MECHANICAL ENGINEER, 31, nine years' design, manufacturing, and field experience high-speed heavy machinery. Desires responsible position with future such as assistant chief engineer with Eastern medium-sized heavy industry. Me-794.

MECHANICAL ENGINEER, BSME, Lafayette College, 1950, 26, veteran. Desires sales-engineering position with promising future. Me-795.

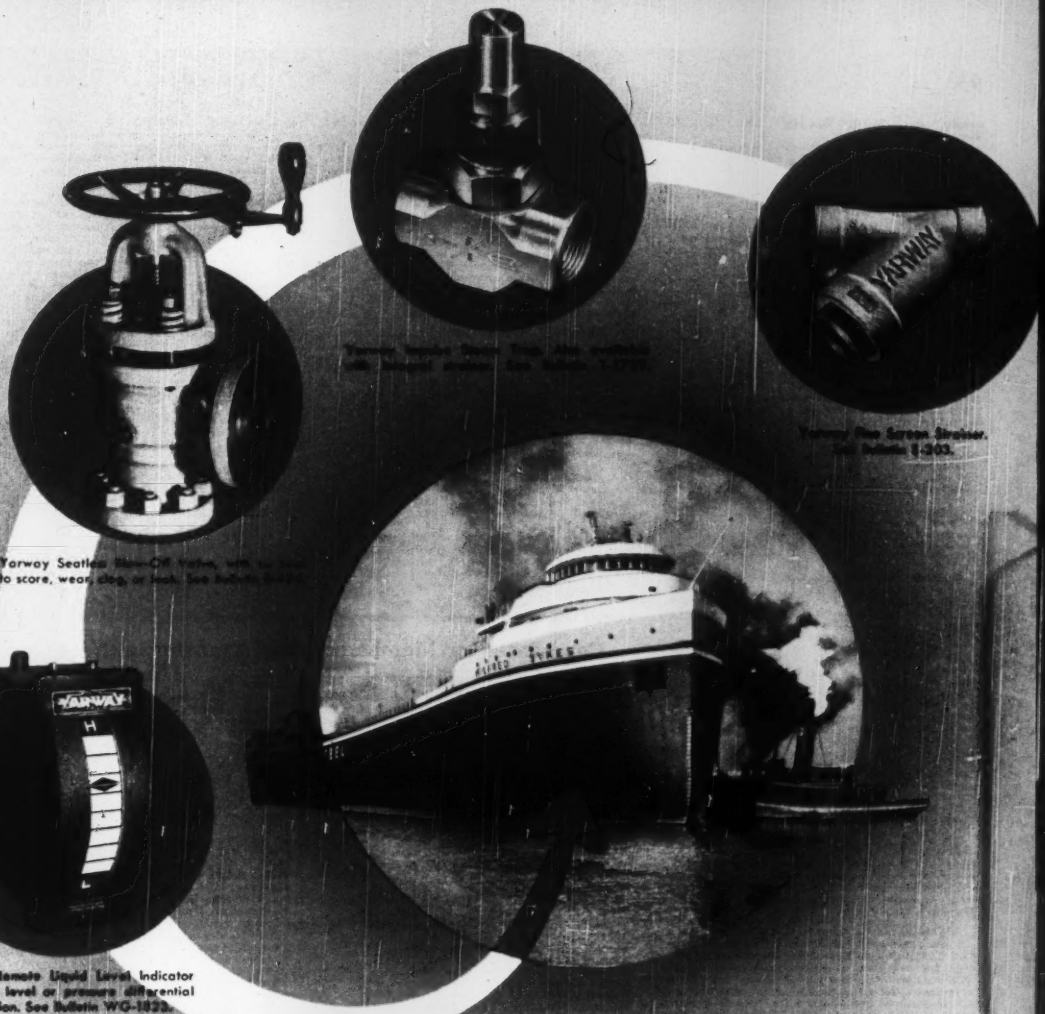
POSITIONS AVAILABLE

DESIGN-DRAFTSMAN, 22-28, mechanical or electrical graduate, for board design work on turbines, centrifugal compressors, and heavy rotating electrical apparatus, covering continuous development on machinery in regular commercial production. Salary open. Western Pa. Y-3923.

RESEARCH AND DEVELOPMENT ENGINEER, preferably under 40, mechanical or electrical degree, experienced in the design and development of fabricated metal products, preferably such products as washing machines, refrigerators, electric

(*ASME News continued on page 950*)

[1] All men listed hold some form of ASME membership.



Yarway Seatless Blow-Off Valve, with [illegible] to score, wear, clog, or leak. See Bulletin [illegible].

Yarway Fine Screen Strainer. See Bulletin S-203.

Yarway Remote Liquid Level Indicator for water level or pressure differential indication. See Bulletin WG-1828.

the "WILFRED SYKES" signs on a Yarway Crew

When the "Wilfred Sykes," largest ship on the Great Lakes, went into service recently, she was fitted out with four kinds of Yarway steam plant equipment.

The engineers who designed this newest and greatest of Inland Steel Company's freighters, selected Yarway Remote Liquid Level Indicators, Seatless Blow-Off Valves, Impulse Steam Traps, and Fine Screen Strainers.

Just as dependable for marine use as they are in thousands of steam plant installations across the land, these Yarway products are helping this Great Lakes ship set new records in her ore-carrying runs from Duluth to Indiana Harbor.

If you're looking for the kind of service in your plant that marine engineers *must* have in theirs, check on these Yarway products. There's a Yarway office near you, or write direct for the product bulletins you want.

YARNALL-WARING COMPANY
108 Mermaid Ave, Philadelphia 18, Pa. • Branch Offices in Principal Cities

YARWAY

STEAM PLANT EQUIPMENT

ranges, etc. $10,000–$14,000. East. Y-3954. Reopened.

ASSISTANT PLANT ENGINEER, 28–35, mechanical graduate, design, layout, specification, installation, and maintenance experience, to be responsible for equipment installation and maintenance in chemical and metallurgical process plants. $4200–$4800. New Jersey. Y-4201.

ASSISTANT PLANT ENGINEER, mechanical graduate, minimum of five years' experience, preferably in drug or cosmetic manufacturing plant. $6000–$7000. Upstate New York. Y-4204.

METHODS ENGINEER, 28–35, mechanical graduate, with experience in graphic-arts industry covering time study, methods, production, and costs, to improve printing operations, cutting and sealing of paper, warehousing, shipping, etc., for paper-products firm. Salary open. New York, N. Y. Y-4225.

MACHINE DESIGNER, 35–55, at least 10 years' tool-design, machine-tool, and special automatic-machinery experience, to supervise special equipment design and tooling for precision-instrument manufacturer. $7500. Queens, N. Y. Y-4228.

MECHANICAL DESIGNER, at least 10 years' experience covering heating, plumbing, air conditioning, etc., to design, lay out, and prepare specifications for commercial and housing projects. $5000–$6000. New York, N. Y. Y-4239.

ASSISTANT GENERAL MANAGER, 37–45, mechanical or electrical, considerable experience in industrial management, particularly in administrative work on budgets, cost control, etc. To $10,000. Conn. Y-4252.

DESIGN ENGINEER, mechanical-engineering graduate, minimum of eight to 10 years' experience covering design and layout of pressure vessels, heat exchangers, and chemical equipment, to supervise design section of consulting firm. Salary open. New York, N. Y. Y-4259.

TEACHING PERSONNEL. (*a*) Assistant professor, at least a master's degree, and preferably a doctor's degree, to teach in the field of machine design. Interest in research work absolutely necessary. (*b*) Instructor to teach applied mathematics and mechanical vibrations. Master's degree desirable. Positions start about Feb. 1, 1951. Southwest. Y-4264.

SENIOR INDUSTRIAL ENGINEER, considerable experience on cost and cost-analysis problems. Should have been employed as a plant manager or industrial engineer in large organization. Experience with a consultant desirable. Traveling. $7000–$8000. Headquarters, New York, N. Y. Y-4273.

DESIGN ENGINEER, 30–45, mechanical or electrical graduate, minimum of five years' instrument experience in high-temperature measuring field for design and product-engineering duties with instrument manufacturer. $5200–$6500. Northern New Jersey. Y-4276.

MECHANICAL ENGINEER with a broad theoretical and practical background in the development and design of small precision mechanisms, gears, etc., for complicated electromechanical devices. Will assume complete responsibility for the development, design, and production engineering of all mechanical components for recording equipment, both tape and disk. To $10,000. East. Y-4293.

ESTIMATOR, mechanical graduate, at least eight years' manufacturing experience, preparing detailed cost estimates covering mechanical and electrical equipment and parts to plan and evaluate various aspects of cost-reduction program. $9400–$7600. Ohio. Y-4298-D.

MECHANICAL DESIGNER five to 10 years' experience in heating, ventilating, and air conditioning for firm of consulting engineers. $5700–$6200. New York, N. Y. Y-4307.

DESIGN ENGINEER, mechanical degree, with experience in the design of precision equipment, medium machinery such as speed reducers of the gear type and electric motors (mechanical features), ranging from ¼ hp to 100 hp. Position is essentially a drawing-board job involving some engineering calculations. $5000–$6000. Ohio. Y-4310-D.

MANAGING SALES ENGINEER, up to 45, mechanical background, minimum of five years' cutting-tool experience, plus five years' sales experience, with practical background in cutting tools (reamers, taps, dies) at a shop level and sufficient sales-engineering experience, to handle practical and engineering problems, informed about distributor form of sales, knowledge of general sales organization. Will organize and assist technical and sales force and establish merchandising policies, discounts, and train salesmen for national distribution through suppliers, mill supply houses and distributors. $7000–$10,000. Headquarters, Ill. R-6890.

PRODUCTION-CONTROL MANAGER, about 40, mechanical background, substantial experience with production control (schedule, order, production and material records, material control, trucking, etc.); should have served as production-control manager or assistant in several metal-fabricating operations. Advantageous to have experience on IBM control records for general machine-shop operations including sheet metal and finishing. $7500. Northern Ind. R-6893.

MACHINE DESIGNER, up to 40, mechanical, five years' or more experience in designing production equipment. Knowledge of machine tools. Informed about manufacturing and production practice. Will design heavy production equipment for a manufacturer of machine tools. $6000–$9000. Northern Ill. R-6895.

ENGINEERS. (*b*) Assistant mechanical development engineer, 25–45, two or more years' experience on mechanical production design and development work. Knowledge of domestic products and shop practice. Informed about styling, stylizing. Will develop domestic products and equipment. $4000–$5500. (*c*) Time-study engineer, 25–45, five years time and motion studies and methods on conveyerized assembly operations. Knowledge of spot welding and punch-press work. Informed about sheet-metal fabrication and finishing operations. Setting standards and methods on sheet-metal fabrication; assembly and finishing. Up to $8400. (*d*) Process engineer, 25–50, five years' experience on processing punch-press operations (deep-drawn piercing, blanking, forming, and notching). Knowledge of punch-press dies (deep drawn, compound progressive, and laminated), informed about sheet metal. Will prepare process sheets, cost and material estimates, determine man-hours and set operation sequences. $4800–$5400. (*e*) Process engineer, 25–50, five years' experience on processing machine-shop operations. Will prepare process sheets, cost and material estimates, determine man-hours and set operation sequences. $4800–$5400. Ill. R-6896.

ENGINEERS. (*a*) Designer—head mechanical engineer, five years' experience in prominent engineering office. Broad experience in design of building mechanics including air conditioning, boiler plant, generating station, illumination design and testing. Working knowledge rate and fuel analyses and communications systems. $6500–$8500. (*b*) Service engineer for farm implements, 27–35, preferably agricultural-engineering degree. Must have experience with well-known farm-implement manufacturer or distributor on service matters. Will be responsible for preparation of technical manuals, bulletins, etc., for use by the personnel in retail stores and mail-order houses. To $6000. Ill. R-6899.

SUPERINTENDENT OF BUILDINGS AND EQUIPMENT, to 45, electrical, mechanical, or civil graduate, considerable experience, in complete charge of maintenance department of large hotels or plants. Knowledge of mechanical and electrical equipment. Complete charge of 150 employees, top-level position with large retail stores. $7500–$9000. Ill. R-6912.

DIE DESIGNER, 30–50 engineering degree or equivalent, minimum of five years' experience working with brass, to design forging dies employed in the fabrication of brass and aluminum forgings. Brass experience essential. Aluminum experience optional. Salary open. Michigan. D-6192.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

½ = Re-election; Rt = Reinstatement; Rt & ½ = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

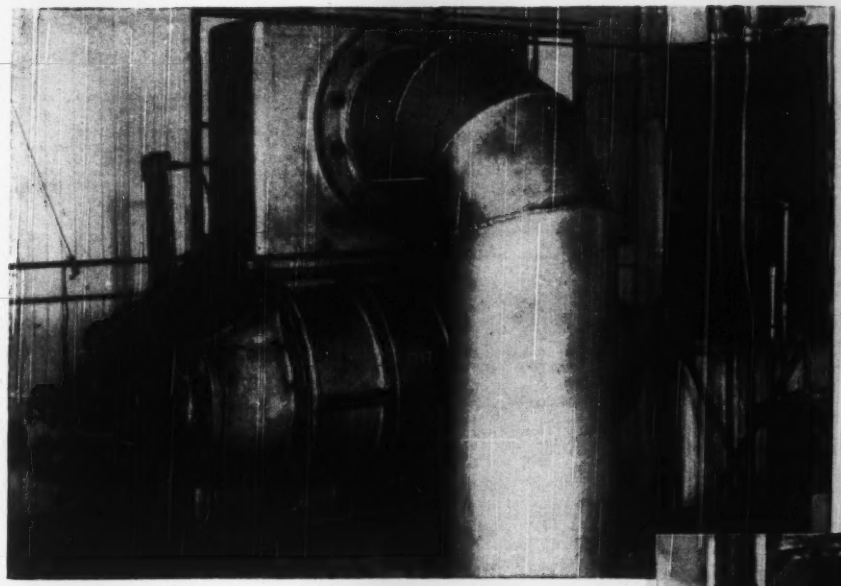
AGTHE, FRED T., Milwaukee, Wis.
AIKMAN, J. L., Drummondville, Que., Can.
ALI KHAN, KUNWAR S., Lahore, Pakistan
ALLEN, HARVEY G., Easton, Pa.
ALLMAN, EDWARD J., Sycamore, Ill.
ANDERSON, ELMER L., Corning, N. Y.
ARTECA, NICHOLAS, Brooklyn, N. Y.
BALEY, JAMES U., Baltimore, Md.
BARTLEY, WILLIAM W., Youngstown, Ohio
BAUMAN, WILLIAM A., Owensboro, Ky.
BENNETT, DALE L., Western Springs, Ill.
BRAENDEL, HELMUTH G., Philadelphia, Pa.
BROWN, EDWARD I., Van Nuys, Calif.
BRUNNER, ALEXANDER, Wilmington, Del.
CARLEY, JOHN E., Bridgeport, Conn.
CHIPPENDALE, ARTHUR J., Jr., Bayside, N. Y.
CLARK, JAMES T., Los Angeles, Calif.
CLINE, WILLIAM H., Jr., Bellaire, Texas
CLYNE, ROBERT, Deerfield, Ill.
CRANE, R. L., Glen Lake, Minn.
CROW, HAROLD E., Denver, Colo.
DISCHINGER, FREDERICK W., Kokomo, Ind.
DOSCHER, HENRY T., Bellmore, N. Y.
GONDA, JOHN E., New Alexandria, Pa.
GREEN, GARRET E., East Orange, N. J.
GRULICK, F. K., New York, N. Y.
GUMZ, WILHELM, Columbus, Ohio
HANSEN, ALBERT, Jr., Lynn, Mass.
HAYS, JAMES R., Cleveland, Ohio
HOLMAN, HARVEY I., Flushing, N. Y.
HURM, DEE CLYDE, Norwood, Pa.
JAMISON, GRAHAME C., Springfield, Mass.
JOHNSON, ROLFE, Washington, Pa.
KARAS, JOSEPH W., Chicago, Ill.
KAYE, SAMUEL L., Los Angeles, Calif.
KOEGEL, WALTER, Baldwin, N. Y.
KONSTANTIN, ANATOLE, New York, N. Y.
LANGSTON, HARRY A., Jr., Los Angeles, Calif.
LAY, JOACHIM E., Dearborn, Mich.
LECOMTE, P., Paris, France
LEONARD, RICHARD R., Worcester, Mass.
LORENZ, RICHARD J., Chicago, Ill.
MARTIN, JOHN W., Jr., Baltimore, Md.
MENON, KOTTIRZATH R., Columbus, Ind.
MILLER, FLORIAN G., Erie, Pa.
MILLER, ROBERT R., Youngstown, Ohio
MITCHELL, PAUL A., Beloit, Wis.
MOORE, T. G., Ware Shoals, S. C.
MORELLI, LOUIS, Erie, Pa.
MORRISON, W. B., Calgary, Alberta, Can.
MORROW, C. E., Riverside, Ill.
MORTENSEN, TAGE A., Kansas City, Mo.
MOUQUIN, W. H., Atlanta, Ga.
MULLER, F. H., Roseland, N. J.
NOILES, DOUGLAS G., Worcester, Mass.
O'ROURKE, J. C., Elmhurst, Ill.
PADIS, LEE ARCHIE, Blacksburg, Va.
PAIVANAS, JOHN ANGELO, Salamanca, N. Y.
PALLANTE, NEIL LUCH, Youngstown, Ohio
PLEUTHNER, RICHARD LOUIS, Buffalo, N. Y.
PODOWJSKI, EDWARD EUGENE, Chicago, Ill.
RAO, V. J., Philadelphia, Pa.
RICE, JAMES F., Hamilton, Ohio
RITCHIE, E. A., Santa Monica, Calif.
SALE, R. M., South San Francisco, Calif.
SANDSTROM, NILS G., Erie, Pa.
SANGER, FRANK M., Wilmington, Del.
SCOTT, KENNETH E., Worcester, Mass.
SCHOLZ, ROBERT L., Washington, Ill.
STACHYRA, EDWARD H., Chicago, Ill.
SUMMER, VIRGIL C., Jr., Parr, S. C.
SYMONDS, P. S., Cambridge, England
TAYLOR, RUSSELL C., St. Louis, Mo.
TINIUS, DAN J., Seattle, Wash.
VON STROH, GERALD, Huntington, W. Va.
WATSON, CHARLES W., Philadelphia, Pa.
WATSON, DAVID J., Clemson, S. C.
WILSON, JAMES F., Akron, Ohio
WOOLDRIDGE, DABNEY E., Jr., Akron, Ohio
WRIGHT, HAROLD E., Dayton, Ohio
ZYNIECKI, EDWARD C., Jr., Detroit, Mich.

CHANGE IN GRADING

Transfers to Member and Associate

AGNEW, JOHN THOMAS, Philadelphia, Pa.
ANDERTON, EARL F., Swarthmore, Pa.
BERRY, WILLIAM R., Camden, N. J.
BONSAL, RICHARD I., Montclair, N. J.
BOYLE, ROBERT G., Los Angeles, Calif.
BROSEMER, ROBERT L., Sacramento, Calif.
BURNEY, HAROLD W., Gainesville, Fla.
CHRISTENSEN, R. W., Chicago, Ill.
COOPER, SAMUEL E., Canton, Ohio
CROOKS, HOMER L., San Gabriel, Calif.
DIETZGEN, JOSEPH E., Winnetka, Ill.
EVANS, PORTER H., Jr., Hempstead, N. Y.
FARNELL, GEORGE, Phillipsburg, N. J.
FELD, LOUIS, Newark, N. J.
FISCHER, ERNEST A., Lodi, N. J.
FLOREEN, ED, Dowagiac, Mich.
FREEMAN, MATHEW L., 4TH, Dallas, Texas
HARVEY, ROBERT D., Huntington Woods, Mich.
HATCH, JOHN P., Hanover, N. H.
HELIN, WALTER E., Mt. Vernon, Wash.
LEE, ADOLPH O., Minneapolis, Minn.
MALONEY, JAMES D., Jr., Knoxville, Tenn.
MARSHALL, DONALD M., Manchester, Conn.
MARTIN, ROBERT H., West Collingswood, N. J.

(*ASME News continued on page 952*)



Installed in 1926, this unit, still in service, attests to the long-time, accurate performance of R-C Meters.

NO PENSION

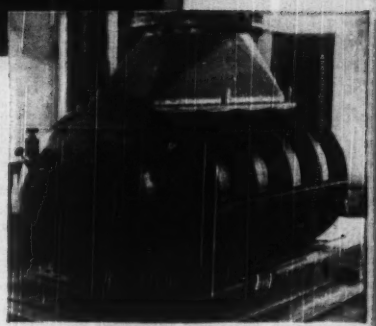
for this old-timer even after 23 years

Accurate and dependable as always, this 23-year-old Roots-Connersville Meter still performs faithfully. No retirement for this veteran! Because new demands called for higher capacity, it has been transferred to another job in the same plant. Its old duties have been taken on by a new R-C unit, purchased because of fine performance of this old-timer.

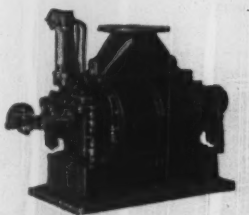
That's a common history of R-C Meters. They're built to measure accurately, and keep on doing it, year after year. Simple design, finely machined measuring surfaces and other important refinements account for their ability to measure gas accurately and unfailingly, almost indefinitely.

With 31 standard sizes and capacities from 4,000 to 1,000,000 cfh, R-C Meters meet the needs of most manufacturing and industrial applications. Write for Bulletin 40-B-14 or tell us your specific requirements.

ROOTS-CONNERSVILLE BLOWER CORPORATION
911 Michigan Avenue, Connersville, Indiana



This R-C Meter, with capacity of 317,000 cfh, replaced the "old-timer" above, now transferred to other duties.



Typical small capacity R-C Meter for low and medium pressures.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

DOING ONE THING WELL FOR ALMOST A CENTURY

NYE, EDWIN P., State College, Pa.
OVERBAGH, JOHN S., Madawaska, Me.
PATTERSON, ROBERT C., Chattanooga, Tenn.
PIECUCH, ALFRED J., Cincinnati, Ohio
POND, JULES, Bangkok, Siam
RANINEN, ARNOLD B., Havre de Grace, Md.
SCHARPER, EARL H., Lincoln, Neb.
SCHEIDT, KARL H., Jr., Louisville, Ky.
SETTERHOLM, VERNON M., Silver Spring, Md.
SHANK, PHILIP R., Rosemont, Pa.
SIMS, EUGENE R., Jr., Columbus, Ohio
SOONG, WILLIAM E., Chicago, Ill.
STECKEL, RENE J., Wauwatosa, Wis.
STEINER, BERNARD J., Englewood, N. J.
STOVER, HOWARD R., Munster, Ind.
TOWNSEND, T. H., Jr., Knoxville, Tenn.
VAN OVERVERN, JOSEPH P., Hayward, Calif.
WADE, GARTH S., Peterborough, Ont., Can.
WEAVER, RICHARD B., Harvey, Ill.
WEST, ROBERT F., Amesbury, Mass.
YORK, J. LOUIS, Ann Arbor, Mich.
YOUNG, GEORGE B. W., Los Angeles, Calif.
YOUNG, GUSTAVE, Roselle, N. J.
ZWISSLER, LEWIS E., Jersey City, N. J.

Transfers from Student Member to Junior 200

Obituaries

Charles Metcalf Allen (1871–1950)

CHARLES M. ALLEN, professor emeritus of hydraulic engineering since 1945, after having taught for 51 years; director, Alden Hydraulic Laboratory, Worcester Polytechnic Institute; originator of the salt-velocity method of measuring flow; and consultant to government agencies and private companies, died at his home in Holden, Mass., Aug. 17, 1950. Born, Walpole, Mass., Dec. 12, 1871. Parents, Meizar Waterman and Martha (Metcalf) Allen. Education, BS, Worcester Polytechnic Institute, 1894; ME, 1896; MS, 1899. Married Eva May Taylor, 1897. He was the author of many books and papers in the field of hydraulic engineering. Received Hon. DS, Worcester Polytechnic Institute, 1929; James Laurie Prize, ASCE, 1925; Clemens Herschel Award, Boston Society of Civil Engineers, 1928; Worcester Reed Warner Medal, ASME, 1936; Elliott Cresson Medal, The Franklin Institute, 1942; John Fritz Medal, 1949. Jun. ASME, 1901; Mem. ASME, 1903; Fellow ASME, 1936; Hon. Mem. ASME, 1944. He was a member of the Board of Managers, ASME, 1928–1931; vice-president, 1931–1933; also served the Society on the Hydraulic Prime Movers Test Code Committee. Survived by wife and three children, Lieut. Comdr. Lucian Allen, USNR; Virginia, Jeannette (Mrs. Andrew J.) Adams, a brother, Philip R., and a sister, Mrs. Emily A. Keedy, Walpole, Mass.

Stephen Ignatius Balogh (1874–1950)

STEPHEN I. BALOGH, consulting engineer, owner of his own company, Seattle, Wash., died July 31, 1950. Born, Budapest, Hungary, June 3, 1874. Parents, Laszlo Istvan and Virginia G. (Beck) Balogh. Education, Gyor (Hungary) Real School; ME, Royal-Joseph University, 1897; studied electronics, Columbia University, 1939–1942. Naturalized U. S. citizen, 1927. Married Gizella Komaromy (died 1947). Received Franz Joseph Cross, first order. Mem. ASME, 1927. Survived by son, Stephen.

Irvin C. Brotzman (1900–1950)

IRVIN C. BROTZMAN, domestic operations manager, Lone Star Cement Corp., New York, N. Y., died at Bethlehem, Pa., Aug. 17, 1950. Born, Phillipsburg, N. J., Nov. 27, 1900. Parents, William Bloom and Annie (Piggott) Brotzman. Education, BSME, Lafayette College, 1922. Married Marian Crandell, 1925. Assoc. Mem. ASME, 1928; Mem. ASME, 1935. Survived by wife and two children, Anne Patricia and John Irvin.

Gilbert Dunning Burleigh (1912–1950)

GILBERT D. BURLEIGH, assistant superintendent of production, Pennsylvania Electric Co., Johnstown, Pa., died of a heart attack on Aug. 22, 1950. Born, Scranton, Pa., March 9, 1912. Parents, Robert Bruce and Ellen V. (Dunning) Burleigh. Education, ME, Pennsylvania State College, 1937; ME, 1948. Married Ruth Dishart, 1942. Mem. ASME, 1946. He wrote many articles which were published in technical journals. Survived by wife and two sons, Robert Bruce and Douglas Dunning.

Albert Grieve (1878–1950)

ALBERT GRIEVE, retired municipal engineer, Lima, Peru, died of a heart attack, July 2, 1950. Born, Lima, Peru, May 28, 1878. Parents, Juan C. and Grimanesa (Becerra) Grieve. Education, Colegio de Guadalupe, 1885–1894; School of Engineering, 1895–1898. Mining Engineer, 1898 (Lima). Married Alicia Madge, 1908 (died 1936). Received Municipalidad de Lima Gold Medal, 1936 and 1948; Ministerio de Fomento, 1903 Gold Medal. Assoc. Mem. ASME, 1915; Mem. ASME, 1935. Survived by five sons, Albert, Richard, Juan, Gorge, Jose.

Howard Hancock Harrigan (1898–1950)

HOWARD H. HARRIGAN, superintendent, Buzzards Point Generating Station, Potomac Electric Power Co., Washington, D. C., died June 24, 1950. Born, Baltimore, Md., Nov. 11, 1898. Parents, John Wesley and Annie (Hancock) Harrigan. Education, Maryland Institute; Baltimore Polytechnic Institute, Johns Hopkins University Evening School. Married Ruth Marion Twigg, 1921. Mem. ASME, 1943. Survived by wife and two children, Ensign Nancy Lee Harrigan, USN, Portsmouth, Va., and Howard H., Jr., Tacoma Park, Md.

Arthur Royland Herbert (1894–1950)

ARTHUR R. HERBERT, district manager, Philadelphia Gear Works, Inc., Chicago, Ill., died Aug. 29, 1950. Born, New York, N. Y., June 14, 1894. Education, BS, University of Rochester, 1925. Mem. ASME, 1944.

Arthur M. Hiatt (1922–1950)

ARTHUR M. HIATT, industrial engineer, The Peoples Gas, Light, and Coke Co., Chicago, Ill., died Feb. 3, 1950. Born, Pennville, Ind., Jan. 2, 1922. Parents, Edgar Raymond and Mary (Wright) Hiatt. Education, BSME, Ohio State University, 1948. Jun. ASME, 1948. Survived by parents.

Oscar Anton Kisa (1886–1950)

OSCAR A. KISA, consulting engineer, Milwaukee, Wis., died Aug. 2, 1950. Born, Troppau, Austria, July 26, 1886. Parents, Edward and Mary Kisa. Education, high school and junior college, Troppau; ME, Imperial Technical University, Vienna, Austria. Married Lore Duino, 1917. Mem. ASME, 1936. Survived by wife.

Daniel Maries Mackie (1865–1950)

DANIEL M. MACKIE, retired tool designer, methods department, Chain Belt Co., died Aug. 8, 1950, at his home in Wauwatosa, Wis. Born, Aberdeen, Scotland, Dec. 14, 1865. Parents, John and Margaret (Maries) Mackie. Education, attended technical schools in London, England, and Aberdeen, Scotland. Married Catherine Ann Loosed, 1894 (died 1933). Mem. ASME, 1941. Survived by a daughter, Edna Mackie Harsh, Wauwatosa, Wis.

Gustaf Adolph Marin (1907–1950)

GUSTAF A. MARIN, whose death was recently reported to the Society, was sales representative, Babcock and Wilcox Co., Minneapolis, Minn. Born, Manistique, Mich., Jan. 1, 1907. Education, BSME, University of Michigan, 1930. Mem. ASME, 1947.

Frank Sawford (1875–1950)

FRANK SAWFORD, retired consulting mechanical and electrical engineer, died in Vancouver, B. C., Can., Aug. 24, 1950. Born, Normantown, Yorkshire, England, Feb. 12, 1875. Parents, John and Sarah Ann (Swann) Sawford. Education, Normantown Church School; Welwyn (Herts) School; Normantown Continuation School. Married Harriet Austin, 1897 (died 1899); son, Frank. Married 2nd, Martha Ann Worthington; son, Philip, and daughter. Invented steam flowmeter, recording gas colorimeter, socketless electric lamp, smoke-density meter, crankshaft-alignment indicator. Author of many papers published in technical journals. Survived by wife and three children, Frank, Vancouver, B. C., Can.; Philip, Toronto, Ont., Can.; Mrs. Elmer G. Johnson, Berkeley, Calif.

Arnold Stucki (1862–1948)

ARNOLD STUCKI, president, A. Stucki Co., Pittsburgh, Pa., died Jan. 11, 1948. Born, Blumenstein, Switzerland, Oct. 30, 1862. Parents, Christian and Anna (Hanni) Stucki. Education, 3 years, Meiringen, Switzerland, 3 years, Munchenbuchsee (Switzerland), graduated in 1880. Married Anna B. Wolf, 1887 (deceased). Mem. ASME, 1907. Survived by daughter, Mrs. Emma (William C.) Hansen, Pittsburgh, Pa.

ASME Master-File Information

(Not for use of student members)

Please print — **Check mailing address**

Name ..... (Last, First, Middle)

Home address ..... (Street, City, Zone, State) ☐

Name of employer .....

Address of employer ..... (Street, City, Zone, State) ☐

Product or service of company .....

Title of position held .....

Nature of work done .....

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The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

ASME NEWS

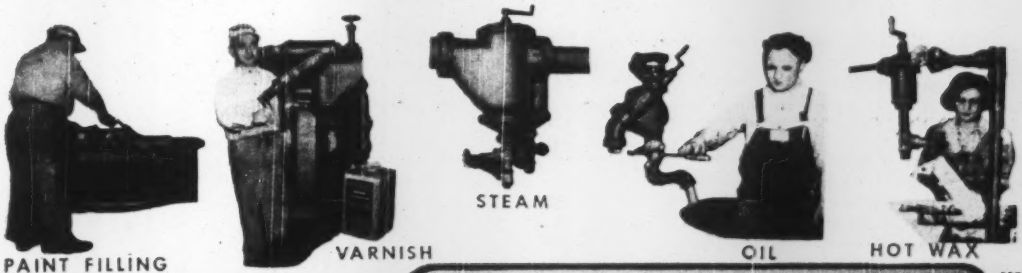
SARCO SCRAPER STRAINERS

—PREVENT WORK STOPPAGES . . . SAVE TIME

The three six inch scraper strainers shown above are insuring a usable water supply 24 hours a day in this busy Detroit paper mill—it is river water which at times is full of debris. Pressure gauges tell the operator when the strainer needs scraping. Then, a few turns of the handles remove all material from the screens and the water pressure becomes normal again.

There are many uses for this Sarco product. Foods and chemicals are run through screens of varying sizes just before packaging. Hot liquids, such as wax and auto frame paint, are purified, and the exhaust steam containing lint from steam hammers is made suitable for use in unit heaters in a large Cleveland metal plant.

Scraper Strainers are available in sizes from ¾" to 8", up to 200 lbs. pressure, hand or motor operated. Bodies, screens and rotors can be made of any metal needed for the application. Ask for Catalog No. 1225.



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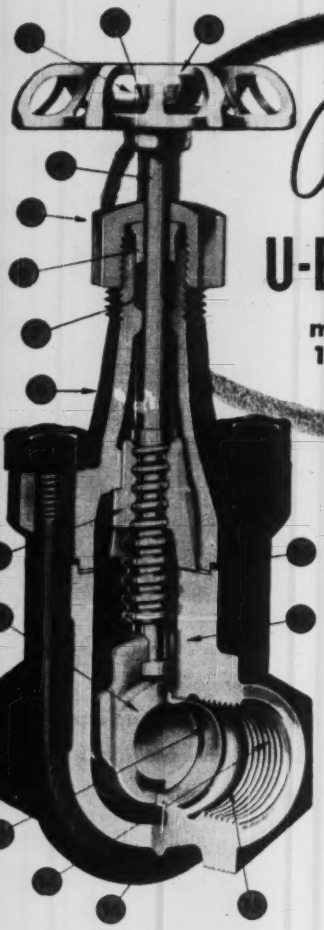

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8. Heavy Duty Bonnet
9. Unique Renewable Bonnet-Saver Bushing
10. Body-Bonnet Safety Joint
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12. Heavy-Duty Body
13. Bronze Seat Rings, Expanded in
14. Full Length Pipe Threads
15. Liberal Diaphragm Clearance
16. Strong U-Bolt

PRESSURES

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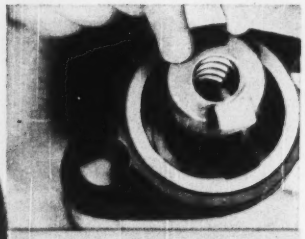
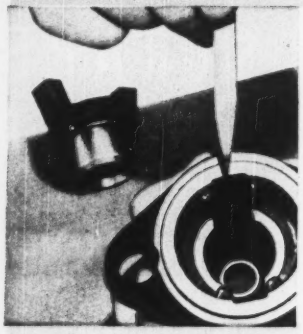
225 lbs. O.W.G.	175 lbs. O.W.G.

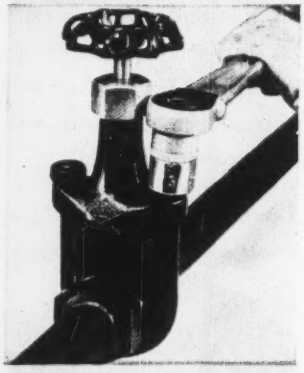
Bronze Mounted or All Iron—Sizes ¼" to 3"



BONNET SAVER BUSHING — No need to junk the bonnet when operating threads are worn. Just slip in a new, patented "Bonnet-Saver Bushing" and have good-as-new thread engagement.



EASY TO CLEAN — You can really get into the bonnet of this valve to clean out the chamber above the operating threads.



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Catalog Index By Products

Accelerometers 194
Actuating Cylinders 142, 161, 177
Aftercoolers 109
Air Conditioning Equipment 156
Air Cooled Engines 128, 215
Air Cylinders 142, 161
Air and Gas Compressors 48, 84
Air Motors 213
Air Preheaters 120
Air Pumps 101
Air Receivers 228
Altimeters 194
Ammonia Compressor Valves 15
Ash Conveyor Equipment 147, 186
Ash Handling Equipment 81
Automatic Controls 33, 80, 88, 92, 116, 165, 168, 182, 193, 227
Automatic Scales 95

Balanced Valves 80
Ball Bearing Swivel Joints 151
Ball Bearings 12, 79, 93, 129, 153, 202
Barrels 228
Bearing Lubricators 77
Bearings 12, 22
Belt Conveyors 39, 214
Benders 172, 195
Bevel Gears 12
Black and White Prints 1, 106
Blast Cleaning 112
Blowdown Systems 224
Blowers 6, 19, 159, 207, 210
Boiler Blowdown Systems 224
Boiler Furnaces 175
Boiler Mountings 148
Books 131, 240
Boring Machines 102
Broaching Machines 169
Bronze Casting Alloys 64
Bucket Elevators 39, 138
Bushings 22

Car Shakers 74
Carbide Metals 163
Cast Iron Pulleys 164
Centrifugal Pumps 26, 31, 53, 127, 185, 206, 222
Chain Drives 133
Chain Grate Stokers 225
Check Valves 109
Choppers 121
Chucking Equipment 142
Chucks 142
Clad Steels 78
Clutches 62, 108
Coal Bunkers 81
Coal Handling Equipment 81
Coal Pulverizers 63
Colored Pencils 37
Compressor Plates and Discs 15
Compressor Valves 15
Condensers 45
Controllers 116, 165, 168
Convectors 242
Conveyor Bearings 202
Conveyors 39, 147, 138, 186, 214
Cooling Systems 109
Cooling Towers 91, 157
Cooling Units 156
Cooling Water Treatment 86
Copper 180, 196
Copper Alloys 180, 196
Copper Tubing 27
Copying Process 1, 106
Corrosion Correction 86
Counters 183
Crushers 39, 121
Cutting Tools 163
Cylinders 177

Data Sheets 72
Deep Drawn Shapes 134, 228
Desuperheaters 80, 109
Die-Less Duplicating 195
Dies 172
Displacement Blowers 6
Displacement Meters 19
Dowtherm Vaporizers 30, 122
Draft Inducers 159
Drafting Room Equipment 96
Drafting Room Furniture 96
Drawing Tables 96
Drop Forgings 54, 152, 197, 219
Drums 228
Dryers 190
Dust Collectors 146, 207, 218
Dust Control 112

Ejectors 109
Electric Heating Units 173
Electric Measuring Instruments 217
Electric Motor Parts 83
Electric Motors 119
Electrically Operated Valves 105
Engines 107, 128, 215
Engineering Forms 72
Evaporators 109, 190
Exhaust Fans 7, 65
Exhaust Heads 209
Exhausters 19
Expansion Joints 5, 170

Fans 7, 65, 159, 210
Feed Water Controls 92
Feed Water Heaters 45
Feed Water Regulators 80
Feeders 39
Felts 187
Files for Tracings 96
Filters 24, 58, 190
Fin Tubing 166
Fittings and Carriers for Wall Fixtures 200
Flat Lapping 40
Flexible Couplings 89, 100, 145, 211, 220, 241
Flexible Metal Hose 16, 184
Flexible Pipe Joints 151, 223, 229
Flexible Shaft Couplings 89
Float Valves 18, 171
Flooring 135
Flow Indicators 35, 43, 109, 130
Flow Meters 212
Flow Regulators 182, 193
Flue Gas Analyzers 149
Fluid Drives 67, 169, 177, 238
Fluid Power Equipment 67, 169, 177, 238
Foam Rubber 87
Forged Steel Flanges 99, 126
Forgings 54, 152, 197, 219
Fork-lift Trucks 198
Fractional Horsepower Gears 93
Fuel Economizers 51
Furnace Walls 28

Gas Analyzers 149
Gas Burners 85, 239
Gas Meters 8
Gas-Oil Burners 85, 239
Gas Pumps 19
Gaskets 144
Gasoline Engines 128, 215
Geared-Head Lathes 32
Gearmotors 76
Gears 12, 93, 136
Grating-Flooring 135
Grinders 121, 203

Hand Trucks 110, 201
Heat Exchangers 109
Heat Transfer Equipment 109, 166
Heating Boilers 61
Heating Elements 132
Heating Units 156, 173
Helical Gears 12
Herringbone Gears 12
High-Speed Motion Picture Cameras 237
High Vacuum Apparatus 4
Hoists 235
Honing Machines 160
Hydraulic Power Units 67, 238
Hydraulic Presses 73, 169, 199
Hydraulic Turbines 174
Hydraulic Valves 97

Indicating, Recording, Controlling Instruments 168
Industrial Scales 117
Industrial Trucks 59, 198
Inert Gas Generators 19
Instrument Valves 75
Instruments 17, 43, 49, 50, 52, 118, 149, 168, 194, 212, 217
Insulated Piping 3
Insulated Piping Systems 3
Iron Cements 46

Lathes 32
Lift Trucks 59, 198
Link Grate Stokers 23, 224
Liquid Level Gages 109
Liquid Level Regulators 80, 88, 193
Liquid Meters 8, 14, 115
Lubricating Devices 148
Lubrication 37
Lubrication Systems 11
Lubricators 77, 148

Machinery Mountings 69
Manometers 43
Marine Boilers 167
Materials Handling Equipment 39, 59, 74, 81, 110, 114, 138, 147, 186, 198, 201, 214, 235
Measuring Instruments 217
Mechanical Counters 183
Mechanical Springs 10
Metal Hose 16, 184
Metal Working Tools 172
Micromatic Microhoning 160
Miniature Ball Bearings 98, 129
Monorail Tractors 235
Motion Study Cameras 237
Motor Operated Valves 105
Multitherm Units 156

Notchers 195

"O" Rings 141
Oil Burners 9, 25, 85, 192, 239
Oil Burning Systems 109
Oil Filters 130
Oil Meters 8, 14, 115
Oil Seals 60
Oiling Devices 130
Oscillographs 17
Overfeed Stokers 44
Overhead Piping Systems 3

Package-type Boilers 20, 30, 90, 178, 231
Packing 25
Photographic Material for Engineering 66
Pillow Blocks 12
Pipe 126
Pipe Fittings 99, 126
Pipe Flanges 126
Pipe Line Conveyors 186
Pipe Swivel Joints 151
Piping 99, 126
Plate Fabrication 45, 188, 197, 229
Plug Valves 8
Portable Conveyors 39, 214
Portable Power Tools 114, 205
Positive Displacement Blowers 6
Positive Displacement Meters 19
Power Benders 195

Continued on Page 42

Use Coupon on Page 42

Power Chucks 142
Power Presses 73, 124, 169
Power Shears 195
Power Take-Offs 108
Power Tools 114, 205
Power Transmission Equipment 12, 22, 29, 38, 55, 62, 67, 76, 79, 93, 98, 100, 125, 129, 153, 164, 177, 179, 202, 211, 216, 220, 233, 238
Power Units 67, 238
Powered Hand Trucks 201
Prefabricated Piping 99
Pressure Cookers 45
Pressure Gages 194, 232
Pressure Pick-ups 194
Pressure Regulators 8, 88, 182, 193, 221, 227
Pressure Transmitters 116
Pressure Vessels 42, 45, 228
Process Equipment 42, 122, 190
Proportioning Scales 95
Propulsion Units 136
Pulleys 12, 164, 211
Pulverizers 63, 226
Pump Drives 155
Pump Governors 80
Pump Seals 158
Pumps 4, 19, 26, 31, 41, 48, 53, 71, 82, 101, 109, 127, 185, 206, 222
Punch Presses 124, 172
Punches 172, 195
Push-Pull Controls 137
Pyrometers 118

Reciprocating Pumps 127
Recording Counters 183
Reducing Valves 80, 109, 171, 221
Refractories 28
Refrigeration Condensers 123
Regulating Valves 171
Regulators 8, 33, 80, 168, 182, 221, 227
Relief Valves 143
Remote Push and Pull Controls 137
Reproduction Materials for Engineering 66
Rod Parters 195
Roll Grinders 203
Roller Bearings 125, 153
Roller Chain Couplings 145
Roller Chains 12, 29
Rotary Blowers 19
Rotary Compressors 48
Rotary Swivel Joints 229
Roughness Measurement 52

Safety Treads 135
Safety Valves 143
Scales 95, 117
Scotch Marine Boilers 167
Screw Conveyors 39
Screw Pumps 127
Screw Thread Inserts 56
Seamless Welding Fittings 126
Separators 101, 209
Shaft Seals 114, 158
Shears 195
Sheave Drives 216
Shredders 121
Silicone Greases 34
Silicone Products 34
Skip Hoists 39
Smoke Density Recorders 50
Smoke Stacks 70
Soot Blower Compressors 84
Soot Blowers 94
Speed Controls 165
Speed Reducers 12, 55, 76, 104, 136, 179, 233
Sponge Rubber 87
Spray Nozzles 157
Spreader Stokers 23, 189, 234
Sprockets 12, 29
Spun End Process 140
Spur Gears 12
Steam Boilers 2, 13, 20, 30, 61, 68, 90, 122, 167, 175, 178, 191, 208, 231
Steam Engines 107
Steam Generators 2, 13, 30, 90, 122, 178, 175, 191, 208, 231
Steam Specialties 109
Steam Traps 36
Steam Turbines 113, 139, 159, 204
Steel 78
Steel Boilers 68
Steel Plate Fabrication 45, 188, 197, 230
Steel Tanks 18
Steel Tubing 27
Steel Valves 154
Stokers 23, 44, 167, 189, 225, 234
Strain Analyzers 21, 111
Strain Gages 21, 111
Strain Measurement 111
Strainers 24, 109
Suction Pumps 71
Sump Pumps 109
Supporting Wall Fixtures 200
Surface Roughness Measurement 52
Swivel Pipe Joints 151, 229

Tachometers 165
Tank Cars 190
Tank Thermostats 171
Tanks 18, 181
Technical Books 131, 240
Technical Data Sheets 72
Temperature Regulators 88, 168, 193
Temperature Transmitters 116
Thermostatic Metals 150
Thermostats 49
Thin Colored Pencils 37
Towers 49
Tracing Files 96
Traveling Grate Stokers 23
Tubing 27, 140, 166
Turbine Type Pumps 31
Turning Machines 102

Underfeed Stokers 23, 44, 167, 234
Underground Piping Systems 3
Unit Heaters 47, 159
Universal Joints 211

V-Belt Drives 236
Vacuum Cleaning Equipment 162
Vacuum Gages 4
Vacuum Pumps 4, 19, 48, 82, 109
Valve Discs and Plates 15
Valves 8, 75, 80, 97, 105, 109, 143, 148, 154, 171, 221, 227
Variable Speed Transmissions 177, 238
Ventilating Fans 7, 65, 159, 210
Vibration Control 69
Vibration Control Mountings 69
Vibration Fatigue Testing Machines 176
Vibrators 114
Vibratory Handling Equipment 114

Wall Fixture Fittings 200
Wall Fixture Supports 200
Walvector 132
Waste Heat Units 30
Water Column Alarms 80
Water Columns 35
Water Gages 35
Water Meters 8, 14, 115
Water Purification 86, 243
Water Softeners 243
Water Systems 31
Water Traps 103
Water Treatment 86, 243
Water Tube Boilers 30, 61, 191
Water Walls 2
Waterspheres 181
Wear Resistant Metals 163
Weighing Scales 95, 117
Welding Fittings 99, 126
Whiteprint Process 1
Worm Gear Speed Reducers 55, 104, 179
Worm Gears 12

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16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243												

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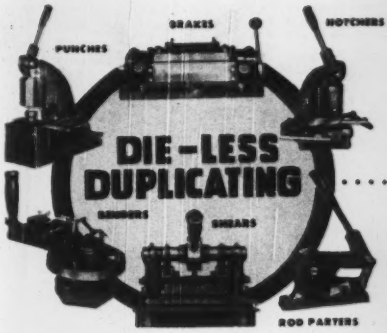
Continued on Page 44



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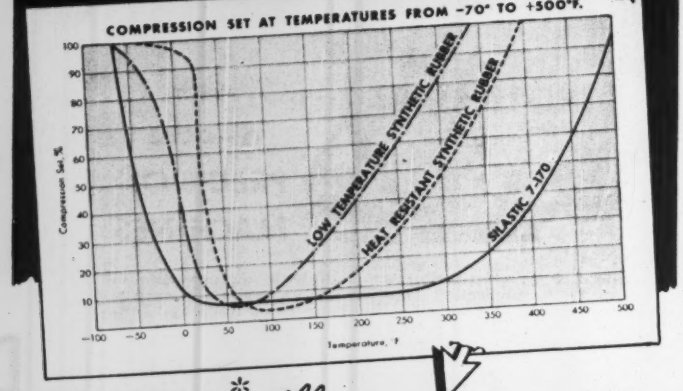

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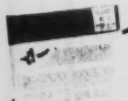

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cally inert packings. The material is completely inert in most chemicals with the exception of molten alkali metals. Styles include both braided form and molded rings. Specific recommendations for each are included.

10 MECHANICAL SPRINGS

Associated Spring Corp.—"The Mainspring," periodical of current thinking on spring-design news and applications. Semi-technical short articles in easy-to-follow style, with humorous illustrations. Covers all types of springs and other pertinent data. Issued every two months. Subscription free upon request.

11 CENTRALIZED LUBRICATION SYSTEMS

Farval Corp.—"Studies in Centralized Lubrication, 1950"—presenting a series of case studies. Farval is a positive mechanical method of delivering oil or grease under pressure to a group of bearings in exact measured quantities. Eliminates guesswork of hand lubrication and insures constant operation of machines without shutdown to lubricate or for bearing repair.

12 GEARS, ETC.

Boston Gear Works—Catalog No. 55 gives complete information and prices on over 4500 stock items including spur, miter, bevel, helical and worm gears, roller chains, sprockets, ball bearings, pillow blocks, couplings, pulleys, speed reducers, rationotors and oil impregnated porous bronze bearings. It provides engineering data, formulas, horsepower rating charts, reference tables and selection charts for figuring the correct power drive and selecting the proper equipment for virtually every mechanical power transmission.

13 STEAM GENERATORS

Ames Iron Works—Bulletin 1011-CM contains cut-away view of "Amesteam" Generator; other interesting pictures; and detailed description of outstanding features. Also lists standard sizes, and fuels for which Units are available. Can furnish detailed bulletin covering your exact needs. See advertisement, page 43 of ASME Mechanical Catalog and Directory.

14 LIQUID METERS

Buffalo Meter Co.—New Catalog of Niagara liquid meters for volumetric measurement of practically all liquids including cold water, hot water, petroleum products, and corrosive oils and solvents, syrups, and many corrosive chemicals. Gives complete information for selecting and installation of meters, also list prices.

15 COMPRESSOR VALVES

J. H. H. Voss Co.—Voss Valves are applicable to any make, size and type of air, ammonia, or gas compressor, are supplied to manufacturers of new machines, as well as to users, for replacing inefficient, unsatisfactory or worn out valves. Designed skillfully for each individual job, made on special machinery from alloy or stainless steel, they are unsurpassed in efficiency, reliability, and safety. Literature explains how and why Voss Valves offer great improvement over obsolete valves or cheap cast iron plate or ribbon valves.

16 FLEXIBLE METAL HOSE

Chicago Metal Hose Corp.—A new, colorfully illustrated Catalog (G-50) has just been issued. This 68-page book contains full description and complete specifications for standard types of flexible metal hose, in a variety of metals. In addition it contains complete sections on expansion joints for piping systems; stainless steel and brass bellows, and various conduits and special assemblies of these components. This catalog is one of the most inclusive books to be issued on flexible metal hose products. It is designed to give those who recommend, specify and install metal hose products one self-contained source of information for all requirements.

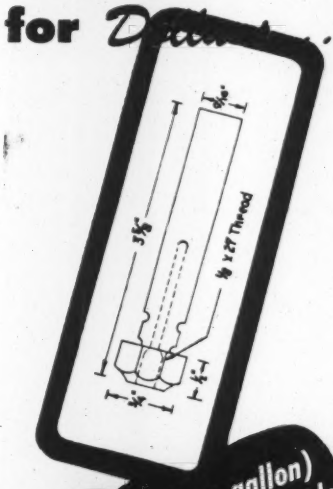
17 RECORDING OSCILLOGRAPHS

Consolidated Engineering Corp.—A new 24-page Bulletin just issued. This publication discusses the applications, operations, and features of these well-known multichannel recording oscillographs. Sample records of actual applications are presented along with detailed assembly drawings. A section, complete with technical information and response curves, is devoted to Consolidated Galvanometers. The balance of the catalog presents accessories, associated equipment, and the Customer Service Plan.

18 TANKS AND TOWERS

W. E. Caldwell Co.—New general Catalog No. 58 with illustrations, data and prices on wood and steel tanks and towers for all purposes, as well as tank agitators, stirring devices, tank heaters, float valves and many other accessories of all kinds.

How to trade *Pennies* for D[illegible]



10c more (per gallon) invested in cutting fluids SAVES $50 PER DAY PER MACHINE!

PRICE alone makes no profit. The drawing above illustrates a shackle bolt which is drilled and tapped on a New Britain Automatic. Using an inferior cutting oil 12 taps were used up every 2½ days—12 pieces per tap. A change to Stuart's SPEEDKUT M on a 2½ day run showed 530 pieces per tap—no taps used up. The saving? Taking into full account the pennies—higher price of Stuart *quality* oil: $50 per day per machine!

If you are interested in a saving like this, ask to have a Stuart representative call. There is no obligation—we'll let Stuart performance do the selling.

Send for your copy of
"CUTTING FLUID FACTS"
Stuart's booklet of cutting fluid data.

D.A. Stuart Oil CO.

2741 S. Troy Street, Chicago 23, Illinois

19 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Corp.—Regularly issues individual Bulletins covering Centrifugal Blowers and Exhausters; Rotary Positive Blowers, Gas Pumps, Liquid and Vacuum Pumps; Positive Displacement Meters, and Inert Gas Generators.

20 SELF-CONTAINED STEAM BOILERS

Cleaver-Brooks Co.—Bulletin SG-128—a complete story of the application of self-contained steam boilers including performance data, service, applications in sizes from 15 to 500 HP and with oil, gas, or combination oil and gas firing. Also steam cost calculator.

21 STRAIN ANALYZERS

Brush Development Co.—Two Bulletins available giving basic information on strain gage circuits and the calculation of simple stresses using wire resistance strain gages. Also many engineers will be interested in specification sheets F-736 giving details on the Brush Direct Recording "Strain Analyzer."

22 SLEEVE-TYPE BEARINGS AND BUSHINGS

Cleveland Graphite Bronze Co.—A condensed 12-page Catalog, "Presenting Bearings and Bushings", illustrates the range and variety of products manufactured in the world's largest bearing plant. Bushings, thrust bearings, heavy-wall bearings, main and connected rod bearings, aircraft engine bearings and camshaft bearings are described and pictured. Also included is description of research and development work, and material analyses for 19 bearing alloys.

23 STOKERS

Westinghouse Electric Corp.—Large-capacity Stokers (up to 350,000-400,000 lbs. of steam per hr.) for Central Station and large industrial users are described in two recent Booklets. Booklet B-3039, "Westinghouse Link-Grate Continuous Ash-Discharge Stokers, type SDL" describes Westinghouse Multiple-retort underfeed stokers with the famous Link-Grate. Booklet B-4553, "Westinghouse Centrafire with traveling Grate," describes outstanding engineering features of the Centrafire (Westinghouse principle of Spreader Firing), including complete hydraulic drives, Oil-Governor type fuel-feed control, and automatic control of fuel distribution . . . the result of seven years' intensive development work. Diagrams and data on actual installations are included.

24 FILTERS AND STRAINERS

Cuno Engineering Corp.—Completely revised Catalog of filters and strainers . . . the answer to nearly any fluid conditioning problem. Catalog contains complete specifications, including engineering drawings, for all standard models. Principles of construction and operation described and illustrated.

25 PROPORTIONING OIL BURNERS

Anthony Co.—New 8-page Bulletin No. 501 gives complete data on Proportioning Oil Burners. Data includes Capacity Tables, Burner Dimensions, Burner Support and Shutter Specifications, Combustion Block recommendations, Typical Blue Print Layouts and list of available accessories and controls.

26 VISCOUS FLUID PUMPS

De Laval Steam Turbine Co.—The De Laval Catalog E313A B describes the new IMO series A313A pump. This is designed for pumping petroleum products and other light or viscous fluids, against medium pressures, as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Capacities to 85 gpm—pressure 150 psi.

27 TUBING

Bundy Tubing Co.—New 20-page Booklet in colors. Contains technical data and fabricating information on Bundyweld steel (copper or tin-coated) tubing of particular interest to production and design engineers in metal-working industries.

28 FURNACE ENCLOSURES

M. H. Detrick Co.—Forthcoming Publication of a comprehensive review of the development of the Art of Enclosing Heat under the title of Heat Enclosure Methods. The text and illustrations will trace each step in the development of modern furnace enclosures from the early sprung arches and solid brick settings to the present suspended and supported walls and arches.

29 ROLLER CHAINS AND SPROCKETS

Diamond Chain Co., Inc.—Diamond Roller Chains, Stock Sprockets and Roller Chains With Standard Attachments are fully illustrated in a new 48-page

Continued on Page 46

THOMAS *Flexible* ALL METAL COUPLINGS

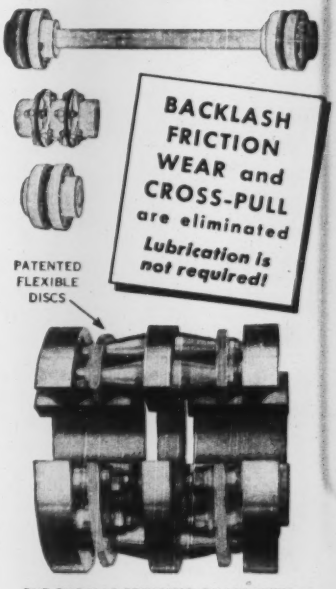
FOR POWER TRANSMISSION REQUIRE NO MAINTENANCE

Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:

½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years



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THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

Another year of evolution of the

ASME
BOILER CONSTRUCTION CODE

brings into effect more than 150 changes, specifications and rules.

These are available now

in the following 1950 addenda

MATERIAL SPECIFICATIONS

Revisions have been made in forty-five of the existing specifications. Some of these are minor adjustments, some are more significant, others are so extensive as to necessitate complete reprinting of twelve specifications. Several new material standards have been added.

POWER BOILER CODE

Amendments to this Section permit the use of deoxidized Bessemer steel pipe or tubing for boiler pressure parts exposed to fire or the products of combustion; add open-hearth and electric furnace steel to specifications previously sanctioned for the fusion welding of drum shells or other parts; require the use of these materials for parts that are to be expanded, rolled or peened into grooved holes in outlet connections.

LOW-PRESSURE HEATING BOILER CODE

Provisions affecting safety and relief valves and pressure testing procedure are among the important revisions of this Code.

WELDING QUALIFICATIONS CODE

A new rule has been added which recommends that steel plates for low-temperature, Chrome-Molybdenum steel plates, and Manganese Molybdenum plates be preheated to at least 350 F when welded.

1950 UNFIRED PRESSURE VESSEL CODE

Most of the fifty changes that have been made in this 1950 Code are minor, although the revision of design for vessels operating under vacuum, and the amplication now permitted in the forms of heads of cylindrical shells are among the provisions which extend the scope of this section.

PRICES OF 1950 ADDENDA:

To 1949 Materials Specifications	$1.00
" " Power Boiler Code	.30
" " Low-Pressure Heating Boiler Code	.40
" " Welding Qualifications Code	.10
" 1950 Unfired Pressure Vessel Code	.35

Remittance should accompany orders of $5.00 or less

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

[redacted]

No. 709 Catalog. Standard single and multiple strand chains from ¼" to 2½" pitch along with a wide range of stock sprockets are also listed and described.

30 STEAM BOILERS

Wickes Boiler Co.—Bulletins No. 44-1-2-3-4, 46-2, 48-1, 48-2 and 49-1 describing water tube boilers of the 2-, 3-, and 4-drum design for direct firing by means of oil, pulverized coal or stokers; also waste heat units, Dowtherm, and package-type water tube boilers; Dowtherm Vaporizers; and Steam Generators. Boilers are built for pressures up to 850 p.s.i. and capacities to 250,000 lbs. of steam per hour.

31 PUMPS

Aurora Pump Co.—Condensed Catalog M, embodying illustrations, suggested uses, specifications, and condensed selection tables for Aurora Centrifugal and Apco Turbine Type Pumps and Water Systems.

32 GEARED-HEAD LATHES

American Steel Foundries, King Machine Tool Div.—2-color Catalogs illustrating and describing Sebastian Standard Type "R" Lathes (Catalog S-1) and Sebastian Special Type "R" Lathes —Gap, Clutch, and Brake, etc. (Catalog S-101). Both catalogs include complete specifications.

33 AUTOMATIC REGULATORS

Powers Regulator Co.—Bulletin 329 gives information regarding No. 11 self-operated regulator, used on water and oil heaters, crude oil treaters, tanks, vats, kettles, dryers, and jacket water cooling for diesel engines and air compressors. Bulletin gives valuable tables for selecting proper size regulator, adequately illustrates broad scope of automatic control, and gives pertinent applications of No. 11 regulator.

34 SILICONE PRODUCTS

Dow Corning Corp.—A Reference Guide to Dow Corning Silicone Products is a new general catalog which lists over 50 different DC Silicones according to their physical form and applications. Important properties of each product and code numbers for obtaining more information about any particular product are conveniently presented in this 4-page bulletin.

35 SIGHT FLOW INDICATORS

Ernst Water Column & Gage Co.—Ernst Sight Flow Indicators are described in a 4-page, 2-color Bulletin, DD. Indicators pictured include, glass cylinder type in iron, bronze and stainless steel; sight glasses, double window flow indicators in both screwed and flanged construction; and single window flapper type are covered. The company's complete line of water columns, gauge glasses, alarms, guards, try cocks and fittings are also discussed.

36 THERMOSTATIC STEAM TRAPS

Sarco Co.—A stainless steel element for pressures to 300 psi and for corrosive condensate is a feature of the new line of Sarco thermostatic steam traps. Condensate and air venting capacities of all traps are practically doubled, thru a new design which permits traps to reach rated capacities with a drop from steam temperature of only 10° F. New Bulletin 250-A.

37 COLORBRITE PENCILS FOR BLUEPRINTS

Eberhard Faber Pencil Co.—Six special colors for blueprint marking have recently been added to the line of Colorbrite thin colored pencils. The colors: Chrome Yellow, Light Green, Scarlet, Orange, Light Blue and White. Colorbrite is recommended for its amazing strength and intense color. Free samples of two of the above colors will be sent.

38 FAFNIR FLANGETTE

Fafnir Bearing Co.—6-page Folder describes a complete power Transmission Unit, incorporating a Fafnir Wide Inner Ring Ball Bearing, and Self-Locking Collar. Housings are interchangeable steel flanges with inside surfaces matching bearing outer ring, thus providing initial self-alignment in all directions. Folder carries photos, installation instructions, sizes and load ratings.

39 ELEVATING AND CONVEYING MACHINERY

Fairfield Engineering Co.—Catalog 150, a technical 250-page catalog containing complete specifications, illustrations, and engineering data covering the many hundreds of products manufactured by Fairfield for various industry conveying, storing and feeding applications in handling materials. The equipment cataloged includes bucket elevators; skip hoists; belt, flight and screw conveyors; feeders; crushers; portable conveyors; tile storage silos.

40 FLAT LAPPING

Crane Packing Co.—12-page Booklet, fully describing the new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic, high production basis. Photographs, diagrammatic drawings and complete data on "John Crane" Lapmaster Models "12" and "24" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and finish.

41 HIGH PRESSURE PUMPS

Aldrich Pump Co.—New Aldrich Data Sheet 64-B describes the recently designed Aldrich 5" Stroke Multiplex Direct Flow Pumps. This 6-page bulletin covers design advantages, construction, specifications and drive requirements. Also included are: a pump selection chart; dimension drawings; plunger, pressure and capacity data on both the 5 and 7 plunger units. The capacity of these two pumps, in bbl. per day at 100 rpm, is from 292 up to 5060 bbl. Maximum pressures range from 614 psi with 3½" diameter plungers to 7500 psi with 1" diameter plungers.

42 PRESSURE VESSELS

Farrar & Trefts, Inc.—New 4-page Bulletin No. 803 illustrates Process Equipment and Pressure Vessels of many types constructed of steel and alloy metals for high pressures and gives complete details of production facilities.

43 V/A CELL KINETIC MANOMETERS

Fischer & Porter Co.—A compact flow indicator and transmitter unit embodying the combined advantages of the area flow meter and the orifice meter providing a large flow range and a linear scale. It requires no mercury, bellows, seals, exterior purges, condensate chambers, or elaborate manifold systems. Described fully in Catalog No. 42.

44 STOKERS

Detroit Stoker Co.—Bulletins covering complete line of Detroit Underfeed and Overfeed Spreader Stokers. Detroit Stokers are unsurpassed for their economy and dependability. Features embodied in the various designs represent over fifty years of experience in stoker manufacture exclusively. As builders of both underfeed and overfeed spreader stokers of many types, sizes and capacities, they are in a position to recommend the kind of stoker best suited for any individual requirement. All grades of bituminous coal are successfully burned without expensive preparation. Operating costs are low, plant efficiencies may be raised to new standards and the capacities of present boilers increased through the use of Detroit Stokers. Proper design and application by experienced builders will produce best results.

45 PLATE PRODUCTS FABRICATION

Fitzgibbons Boiler Co.—6-page Folder describing the facilities in its Oswego, New York Plant for fabricating heavy steel products. It is illustrated by photographs of equipment, as well as of various typical products made for other companies, such as pressure and non-pressure vessels—i.e., Pressure Cookers, Feedwater Heaters, Condensers, etc.

46 IRON CEMENTS

Smooth-On Manufacturing Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time-saving, money-saving metal repairs made on plant, shop, factory, garage and home equipment with Smooth-On Iron Cements. Leaks stopped, cracks sealed, loose parts and fixtures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

47 UNIT HEATERS

Grinnell Co.—Catalog UH-1950 illustrating and describing horizontal and vertical delivery and Textile types of Grinnell Thermoliers. Textile type self-cleaning for use in dusty, lint and fly laden atmospheres. Complete capacities, dimensions, weights, motors, wiring diagrams, piping connections and methods of suspension. Exclusive features described and illustrated.

48 ROTARY COMPRESSORS AND VACUUM PUMPS

Fuller Co.—Bulletin C-5, 16 pages, shows details of construction of these units, both single and 2-stage, for capacities to 3300 c.f.m., pressures to 125 lb., vacuums to 29.90 inches (referred to 30-in. barometer). Bulletin also shows many installation photographs.

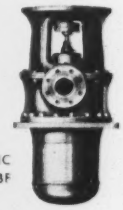
49 THERMOSTATS

Fenwal, Inc.—Catalog on unique Thermoswitch* Heat Control, a precision thermostat having out-

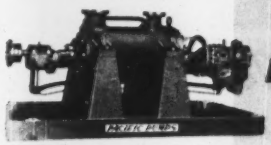
Continued on Page 49

Pacific
BOILER FEED PUMPS
Now being built for

UTILITIES
INDUSTRIAL
POWER PLANTS
MARINE SERVICE



PACIFIC TYPE WBF



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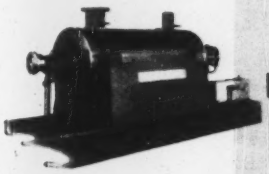
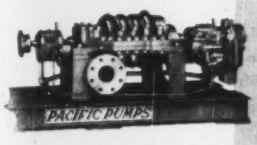


PACIFIC TYPE IBF



PACIFIC TYPE JBF

TYPE	QUANTITY	Pounds Per Hour	Degrees Temp.	Pounds Pressure
WBF	11 Pumps	47,700	259F	710
ABF	3 Pumps	230,000	281F	1110
	3 Pumps	358,120	220F	1300
IBF	3 Pumps	425,000	310F	1825
	3 Pumps	495,000	306F	1619
JBF	2 Pumps	163,600	260F	490
	1 Pump	117,500	250F	775

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PUMPS

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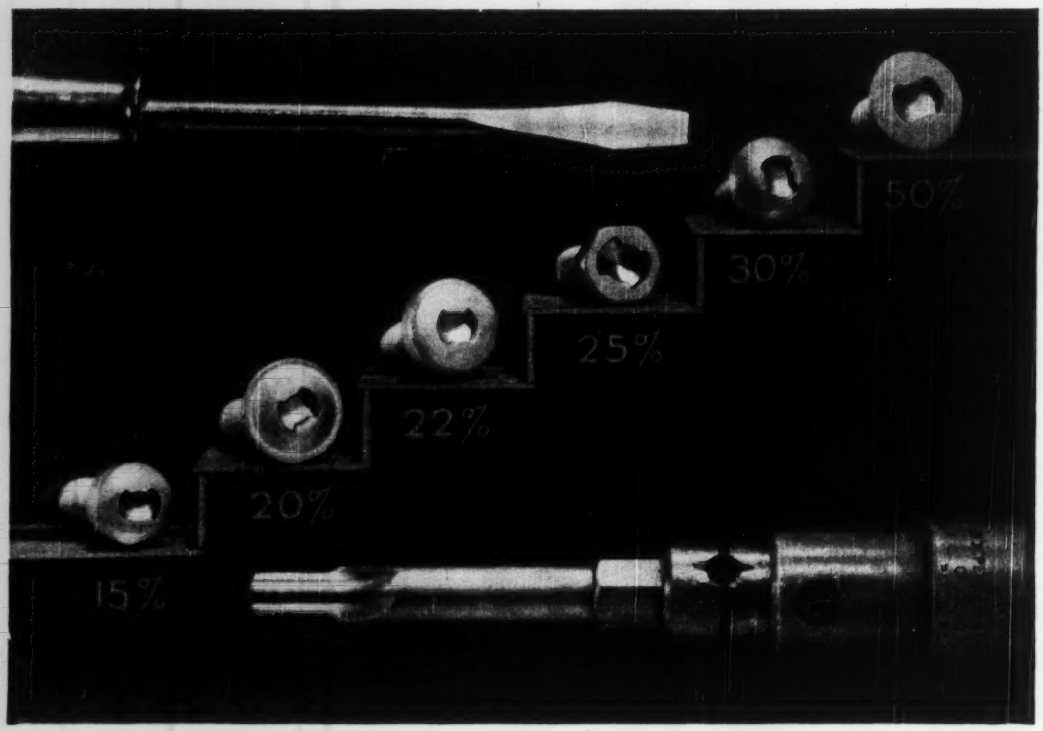


The Percentage Is All in Your Favor

These production increases are from the records of assembly lines where change-over was made from *other* types of *recessed head screws* to CLUTCH HEAD

HERE'S HOW CLUTCH HEAD PAYS OFF IN GAINS AND SAVINGS

High visibility of the recess cancels out slow-down hesitation . . . confident operators logically drive more screws.
Center Pivot entry prevents driver canting, insures straight driving . . . saves cost and delay of "fixing" burred or chewed-up heads.
Non-tapered driving engagement reduces skid hazard to zero . . . protects manpower and saves costly damage to materials.
All-square contact means no "ride-out" (as set up by tapered driving) . . . no fatiguing end pressure needed to combat "bucking."
The CLUTCH HEAD Lock-On hurdles "fumble spots" on the line . . . unites screw and bit as a unit for one-handed reaching and driving.
The rugged Type "A" Assembly Bit for unmatched tool economy . . . drives up to 214,000 screws non-stop on a high torque job.
Check the extra profit stemming from this steady production flow . . . no time-wasting stoppages for frequent tool changing.
Repeatable reconditioning multiplies the life of this bit . . . only a 60-second application of the end surface to a grinding wheel.
This simple operation restores original efficiency, *time and time again* . . . no expense or bother of back-to-the-factory shipments.
Consider the value of simplified field service . . . with a recess basically designed for common screwdriver operation.
Your service men and customers save time on field adjustments . . . any flat blade reasonably accurate in width will do.

These exclusive time and money-saving features are fully described and illustrated in the new CLUTCH HEAD *brochure. Send for your copy, mentioning the sizes and types of screws, standard or special, that interest you . . . to come by mail and without obligation.*

CLUTCH HEAD SCREWS

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

standing advantages of instant response, high accuracy, wide range, rugged construction and ease of installation. Temperature-sensitive element is external metal shell which actuates and protects internal contacts. Catalog describes wide application and gives full engineering details, and shows how Thermoswitch unit can often replace expensive control instruments. (*Reg. U. S. Pat. Off.)

50 SMOKE DENSITY RECORDERS

Bailey Meter Co.—4-page Bulletin explains operation of Bolometer type smoke density recorder. Drawings and photographs illustrate the construction and application of the electronic type smoke recorder, the sealed beam light source, and the sealed beam Bolometer type smoke detector which make up the complete unit for the measurement and recording of smoke densities in ducts and stacks. The Bolometer is described as a modified, sealed beam automobile head lamp which receives all radiation from the light source which is passed by the smoke column. Circuit diagram illustrates method of compensating for voltage variations and ambient temperature changes.

51 FUEL ECONOMIZERS

Green Fuel Economizer Co.—Bulletin No. 169 describes cast iron and steel tube economizers. The advantages of diamond shaped tubes and streamlined flow of gas and soot-blower steam are discussed. Tube arrangement makes the entire outside surface of each tube visible during inspection. Fan bulletin No. 168 is also available.

52 SURFACE ROUGHNESS MEASUREMENT

Physicists Research Co.—Looseleaf Catalog of Profilometer equipment for measuring the roughness of practically all machined, ground and finished surfaces in definite microinch units. Includes information on shop applications of the Profilometer for quality control and production economy, plus separate illustrated descriptive pages with complete specifications on each item of equipment.

53 SELF-PRIMING CENTRIFUGAL PUMPS

Goulds Pumps, Inc.—Complete descriptive Bulletin No. 636.1 on new line of self-priming centrifugal pumps for any service where suction lifts are encountered. ¾ H.P. to 5 H.P. sizes with close coupled and flexible coupling motor drives. Open and enclosed impellers. For suction lifts up to 25 ft. Capacities available up to 120 G.P.M. Heads up to 135 ft.

54 DROP FORGINGS

Drop Forging Association—Revised edition "Metal Quality—Hot Working Improves the Properties of Metal." This new 64-page Booklet issued by the Technical Committee of the Drop Forging Association for users of forgings—design engineers, metallurgists and production and management executives. The booklet describes and illustrates the development of metal quality progressively throughout hot working operations, from the blast furnace to the finished forging. A discussion is presented of forging quality steel and the proper selection of metals for forgings. Steps in making forging dies and the various methods of hot working metal by forging are reviewed. Forging procedures of various kinds of parts are outlined such as parts with thin sections, projections, holes, etc. Economic advantages of forgings are highlighted.

55 WORM GEAR SPEED REDUCERS

D. O. James Gear Manufacturing Co.—8-page illustrated Catalog No. 45-C containing valuable informative engineering data and prices on Single and Double Worm Gear Reducers. Type "S" or Single Reduction comes in 24 sizes, in ratio ranges of 5.66:1 to 100:1 and from .04 to 15 horse-power. Double Worm Gear Reducers are available in 10 sizes with ratio ranges of 87.1 to 10,000:1 and from 106 inch pounds to 3480 inch pounds output torque. Stock sizes, available for immediate shipment, are plainly indicated.

56 SCREW THREAD INSERTS

Heli-Coil Corp.—New Catalog No. 650 on Heli-Coil screw thread inserts is now available to engineers and others concerned with design, production and maintenance. The catalog includes information on insert design, recommended proportions for assembly, length of thread engagement for various materials, handy guide for preparing insert drawings, and specifications on inserts and tools. Insert data covers the most widely used threads in the National Coarse and National Fine series, as well as spark plug threads and taper pipe threads.

57 LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—Announces the release of a new 56-page Lubriplate Data Book 1-50 which contains some very valuable information on the subject of lubrication.

58 TASTE AND ODOR REMOVAL FILTERS

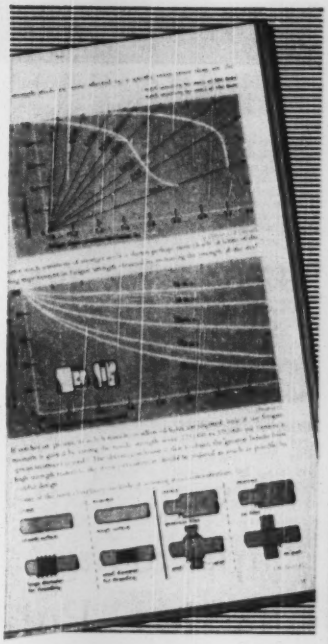
Hungerford & Terry, Inc.—New Bulletin AF-1 gives complete illustrated data on operation of Activated Carbon Filters for removing objectionable tastes and odors including chlorine for pressure operation on potable water supply systems. Units available for manual, semi-automatic or fully automatic operation, employing poppet type central control valve previously announced in Bulletin V-11.

59 LIFT TRUCKS

Hyster Co.—8 pages of model views, action photographs and descriptive text make up Catalog No. 1135, covering the new Hyster 2000 pound capacity lift truck (Model 20) recently announced as completely re-designed and improved. More than 70 basic changes have been made in the compact,

Continued on Page 50

Read the various items listed . . . one catalog may hold the solution to your present problem . . . and select those of interest to you. *Distribution by us to students is not included.* The coupon on page 42 must be mailed on or before December 15th in U. S., December 24th elsewhere.



Every designer must be something of a metallurgist

Here are 72 pages packed with information of vital significance to engineers faced with the design, selection and treatment of steel components to give a specified service at minimum cost.

Besides dealing with scientific design, the book gives important metallurgical data, all compiled from the designer's viewpoint. Free on request.

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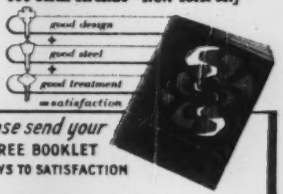

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Position.....
Company.....
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ME-11 F 22

maneuverable lift truck, designed for general industrial materials handling. Specifications and details of the new model are included in the booklet.

60 OIL SEALS

Johns-Manville—Clipper Seal Brochure describes complete story of this precision moulded oil seal that provides efficient bearing protection at low cost. Includes photographs and diagrams of typical installations, shows how various lip designs provide choice of bearing surfaces, how its simple one-piece construction allows greater freedom in designing oil seal cavities.

61 WATER TUBE HEATING AND POWER BOILERS

International Boiler Works Co.—Catalog and Specification Sheet describing Water Tube Steel Heating and Power Boilers, includes pictures and cuts showing effective baffling arrangements which provide economical performance with all fuels and any method of firing. Made in standard sizes from 10 to 600 B.H.P. See our performance data in ASME Mechanical Catalog and Directory, page 168.

62 CLUTCHES

Carlyle Johnson Machine Co.—Installation and Data Book No. 50 covers all types of Maxitorq floating disc Clutches. Drawings, specifications, photos of standard clutches, 8 sizes to 15 h.p. at 100 r.p.m. and driving cups of Pulley type, Cut-off-Coupling Ring type. Overload Release Clutch, Non-locking levers, parts list and installations for machine tools, textile, packaging, mining, printing, industrial trucks, hoists, mowers, etc.

63 PULVERIZERS

Kennedy-Van Saun Mfg. & Eng. Corp.—Bulletin 448 "Radiant Heat From Air Floated Pulverized Coal" contains valuable information for large steam plants showing how to utilize low grade coals, also slack, silt screenings and washings which cannot be used with ordinary equipment. See our advertisement ASME Mechanical Catalog and Directory, page 183.

64 BRONZE CASTING ALLOYS

American Manganese Bronze Co.—50-page Edition of the "Reference Book on Bronze Casting Alloys." In it is given general information regarding composition, characteristics and applications of many of the common or typical alloys. The Book will help the engineer or designer in the selection of the right alloys for any general application.

Every Advertiser appearing in the ASME Publications . . .

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that his products . . . the service in them and the service behind them . . . will stand up under the most searching scrutiny of the high calibre engineers and executives whom these publications serve.

65 AXIAL FLOW FANS

Aerovent Fan Co.—11th Edition Catalog describing Aerovent "Macheta" Axial Flow exhaust and ventilation, 9" to 144", direct connected, belted, extended shaft, mancooler, pulley, duct and belted duct fans.

66 REPRODUCTION MATERIALS FOR ENGINEERING

Eastman Kodak Co.—A line of photographic materials for engineering drawing reproduction is described in a new Booklet, "Modern Drawing and Document Reproduction with Kodagraph Reproduction Materials." Of particular interest to engineers are three direct-to-positive printing room-light-handling materials . . . Kodagraph Autopositive Paper, Kodagraph Autopositive Film, and Kodagraph Autopositive Cloth, which have valuable applications for making intermediates. They can be exposed with conventional drafting room equipment. Also described are Kodagraph Contact Paper and Kodagraph Projection Papers, as well as Kodagraph Contact and Projection Cloths, which meet additional requirements of drafting rooms and reproduction departments.

67 HYDRAULIC ELECTRIC POWER UNITS

American Blower Corp.—New Gyrol Fluid Drive Hydraulic Electric Power Units. "Power in a Package" pictorially described in Bulletin No. 8519. Bulletin mentions applications, shows illustrative test photographs, and includes ratings and dimensions.

68 STEEL BOILERS

Kewanee Boiler Corp.—Kewanee Steel Boilers. Lo and Hi Pressure Series, Welded and Riveted for mechanical or hand-firing and convertible. Steam radiation ratings 1,380 to 42,500 sq. ft. commercial, 330 to 3,000 sq. ft. residential sizes. Shown in 24-page General Catalog 80.

69 VIBRATION CONTROL

MB Mfg. Co.—Products for the detection, reproduction and isolation of vibration are described in Bulletin 410. Booklet contains helpful design data on vibration control, plus information on Isomode pad, Isomode units and details on MB Vibration Exciters and Test Equipment.

70 STEEL SMOKE STACKS

L. O. Koven & Brother—Recently revised Bulletin Koven Steel Smoke Stacks, describes welded and riveted, guyed and self-supporting steel smoke stacks. This valuable folder contains tables, charts and formulas necessary in calculating sizes, capacities, anchoring designs, etc. for all steel stacks. These stacks run from 1' diameter by 15' high to 18' diameter by 225' high. Each Koven-built unit is specially designed to meet the individual requirements of the particular usage and location.

71 DOUBLE-SUCTION PUMPS

Economy Pumps, Inc.—Horizontal, single stage double suction pumps for general water supply and booster service, brine or hot water circulation, condenser injection, hot well or makeup water service, white water and overflow in paper mills are described in new Bulletin No. A-750 Cm. Construction details and selection tables are included.

72 BINDERS AND FORMS

Lefax—Has available for free distribution a 48-page Catalog listing loose-leaf Engineering Technical Data Sheets in the handy pocket size 6¾" x 9¾". Also available is a 32-page catalog listing loose-leaf Engineering Forms and Binders.

73 PRESSES

American Steel Foundries, Elmes Engineering Div.—12-page Bulletin No. 1010-B covers hydraulic metal working presses. Electric control gives semi-automatic operation, automatic operation, and inching with speed change and reversal of slide governed either by ram travel or pressure, whichever is preferable.

74 CAR SHAKERS

Link-Belt Co.—12-page, illustrated Book No. 2345 on new Car Shaker, a compact, self-contained vibrator unit for rapid, economical unloading of bulk granular materials from open top, hopper-bottom gondola cars to conventional track hoppers serving conveying equipment. Particularly recommended for unloading coal, sand, coke, ore, gravel, cinders, etc., and accelerating removal of damp materials frozen in cold weather.

75 NEW INSTRUMENT VALVES

Edward Valves, Inc.—New Edward Bulletin No. 491 providing information on the new drop forged steel Edward Instrument valves for meter, gage, instrument, and other small lines. These new valves have a rating of 6000 lb WOG at 100°F or 1500 lb sp at 1000°F. Bulletin 491 contains dimensions, weights, prices, and operating data.

76 GEARMOTORS

Foote Bros. Gear & Machine Corp.—Engineering Manual GMA fully describes the new Foote Bros.-Louis Allis Gearmotors and contains complete application and selection information and dimensions. These gearmotors employ hard helical gears and other moving parts, specially processed and heat treated by new methods. Single, double and triple reduction units provide output speeds from 780 down to 7.5 r.p.m. Horsepower ratings from 1 through 75 hp. AC and DC motors of all types are available including those with special electrical characteristics.

77 DIESEL SUSPENSION BEARING LUBRICATORS

Miller-Felpax Corp.—New Bulletin describes latest model Felpax Lubricator for diesel locomotive traction motor suspension bearings. Improvements include Truarc rings for quick, easy field replacement of wick sets, and tough, resilient stop plates to prevent scoring journal when wicks are worn near limit. Replacement part kits including complete wick sets and necessary hardware are also described.

78 FABRICATION OF CLAD STEELS

Lukens Steel Co.—Shop-Tested information on the experience of scores of fabricators who have been designing and fabricating Lukens Clad Steel equipment for more than 20 years is contained in the Manual "Fabrication of Lukens Clad Steels", recently published. A handy pocket size reference book for designers, engineers and welders. It is profusely illustrated throughout with photographs, charts and drawings detailing each operation.

79 BALL BEARINGS

New Departure, Div. of General Motors—Supplementing its standard Catalog, a series of five books helpful to the engineer and designer in applying ball bearings to any new machine. The first book deals with principal bearing types and fundamentals of mounting practice; the second, details of shaft and housing designs; and the third, enclosure and lubrication for varying operating conditions; the fourth book gives a new simplified method of computing bearing loads, while the fifth entitled, "Application Procedure," outlines the necessary steps in obtaining assured bearing performance.

80 FEED WATER REGULATORS

Northern Equipment Co.—Bulletin 443-D provides factual data and many tables of sizes and capacities for its complete line of Feed Water Regulators, Differential and Pressure Reducing Valves, Pump Governors, Balanced Valves, Desuperheaters, Liquid Level Controls and Hi-Low Water Alarms. A quick reference bulletin which also lists comprehensive catalogs available on each Copes product, for more detailed information.

81 COAL HANDLING EQUIPMENT

Gifford-Wood Co.—24-page Bulletin No. 300 describes the Gifford Wood "4 Basic Types" of coal handling installations, namely, concrete silo, tile silo, cylindrical steel tank and suspended steel bunker. Contains illustrations and working drawings of all four types of installations in many industries. Auxiliary equipment for coal and ash handling is also shown.

82 MECHANICAL VACUUM PUMPS

Kinney Manufacturing Co.—High Vacuum Pump Bulletin V45 contains the latest technical information on the design and operation of Kinney High Vacuum Pumps. Complete reference tables and engineering data are given, together with information on the installation of vacuum systems and the selection of the proper pump and accessories. The catalog, fully illustrated in color, will prove a helpful guide to all those interested in the rapidly expanding field of vacuum processing.

83 MATCHED MOTOR PARTS

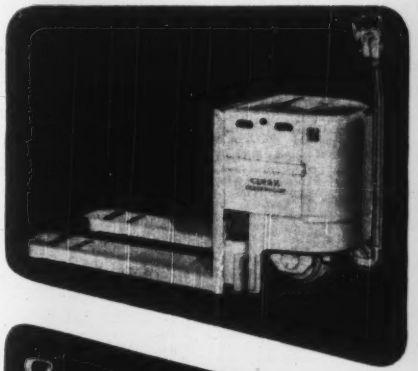
Robbins & Myers, Inc.—Catalog Series 400, complete guide to modern motor application. A fully-illustrated, 36-page handbook with exploded views and detailed drawings which solve many powering problems. Specifications, sizes, and performance characteristics of component parts for all motor types and requirements. A

Continued on Page 52

Biggest Materials Handling news in years

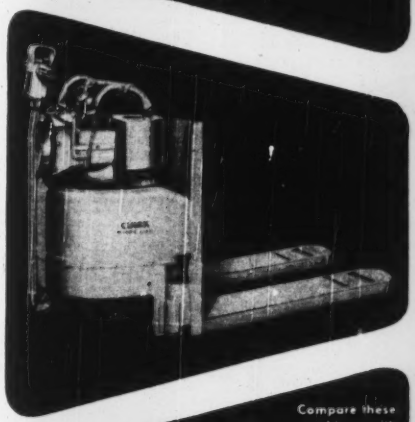
CLARK'S REVOLUTIONARY *New* POWERED HAND TRUCKS

• GAS OR ELECTRIC POWER • SHORTEST TURNING RADIUS • MORE POWER! • MOTORS IN THE DRIVE WHEEL



1 Electro-Lift

New-type compound motor develops more power than any other electric truck. Ample reserve power—high gradability. Automatic acceleration. Soft, dynamic braking. Requires minimum operator effort because speed variations are negligible. 19-plate batteries.



2 Hydro-Lift

Gas-engine drives variable-displacement hydraulic pump which drives constant-displacement hydraulic motor with unequalled smoothness and controllability. 24-hour ramp service. Automatic torque multiplication—big reserve power. Effortless finger-tip positioning of directional controls.

One Basic Design

Same rugged frame for both power types. Shortest wheelbase. Larger (14") drive tire carries greater share of load—lessens weight on rollers—less wear on rubber and floor. Greatest underclearance. Compact drive unit fully enclosed. Largest main carrier bearing of all hand trucks.

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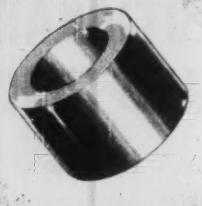

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ready reference manual that will prove especially helpful to design and product engineers.

84 SOOT BLOWER COMPRESSORS

Pennsylvania Pump & Compressor Co.—Bulletin No. 207 describes the Company's Soot Blower Compressors designed for the use of compressed air for soot blowing in the Modern Power Station.

85 COMBINATION GAS-OIL BURNERS

Petroleum Heat & Power Co.—Bulletin No. 150-B describes Petro Industrial Combination Burner Model GW-5A-E. Designed to release 5,200,000 BTU/hr. with any standard #5 fuel oil or natural gas of 1000 BTU/cu. ft., without interchange of equipment. Furnished with all standard controls and auxiliary accessories for direct or belt drive, wholly or semi-automatic, operation.

86 CORRECTING WATER PROBLEMS

D. W. Haering & Co.—A number of valuable and interesting Pamphlets on scale and corrosion correction in industrial plants have been prepared by this company. For instance "Cooling Water," "Organic Methods of Scale and Corrosion," "Cooling System Problems," and several other bulletins that are very helpful in correcting Water Problems in industrial plants.

87 FOAM RUBBER, SPONGE RUBBER

Sponge Rubber Products Co.—New 12-page Folder illustrates shapes and forms, into which cellular rubber can be molded or die cut, tubing, cord, strips, sheets, rolls, pads. Describes typical applications in sealing, insulating, gasketing, dust proofing, weather stripping, sound deadening, shock absorption. Offers experimental examples.

88 AUTOMATIC CONTROLS

Mercoid Corp.—A complete line of automatic controls and mercury switches are illustrated and described in Mercoid Catalog No. 700. These electrically operated controls cover a wide range of applications involving the automatic control of pressure temperature, liquid level and for lever arm mechanical operations. Various types of mercury switches are made in numerous circuits.

89 FLEXIBLE SHAFT COUPLINGS

Poole Foundry & Machine Co.—Poole flexible coupling Catalog No. 44 covering general engineering information, data, horsepower ratings, dimensions, weights, all types of standard and mill motor, vertical, disengaging, and other types of flexible couplings.

90 UNIT STEAM GENERATORS

Preferred Utilities Manufacturing Corp.—Latest edition of Bulletin 1000 fully describes Preferred's Unit Steam Generator which has fully automatic operation even with No. 6 oil. A cutaway illustration shows the 4-pass, down draft gas travel, low furnace, and other features that result in a high thermal efficiency over a long life with a minimum of maintenance.

91 SPECIALIZED EQUIPMENT

J. F. Pritchard & Co.—Catalog L 19.092 illustrates and describes the different types of cooling towers, from the small Series "P" to the largest mechanical and natural draft towers. Also shown is air and gas treating equipment. Listed are services performed by the Power, Chemical, Petroleum and Natural Gas Divisions.

92 BOILER FEEDWATER CONTROL

Republic Flow Meters Co.—New Bulletin No. S-52 describing and fully illustrating the one, two and three element boiler feedwater control system. A comparison of the three systems and the advantages of each are featured in this 8-page brochure.

93 FRACTIONAL HORSEPOWER GEARS

Gear Specialties, Inc.—6-page Catalog Bulletin illustrating and describing different types and applications of G.S. Small Gears. Some applications without precedent; new principles, new design, new engineering. Gears from 12 to 96 D.P.

94 SOOT BLOWERS

Hahn-Pitz Corp.—Catalog No. 61 describes fixed nozzle Mechanical Soot Blower for fire-tube boilers. Economical, guaranteed efficiency. No moving parts.

95 AUTOMATIC WEIGHING AND PROPORTIONING SCALES

Richardson Scale Co.—Bulletin 0450 is a "Guide" for automatic weighing, proportioning and packing of over 200 materials. Automatic scales, augur packers, oscillating packers, control panels, com-

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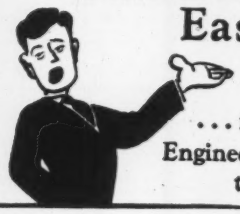

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pounding bins are described, with capacities, speeds, and characteristics. Essential information for all process and materials handling engineers.

96 DRAFTING ROOM EQUIPMENT

Hamilton Manufacturing Co.—Drafting equipment described in Hamilton Catalog No. 13-S. . . . Auto-Shift tables with instant adjustment for height and slant from horizontal to vertical . . . tracing files with patented tracing lifter, making every sheet a top sheet . . . and a complete line of files and drawing tables to meet all requirements.

97 HYDRAULIC VALVES

Rivett Lathe & Grinder, Inc.—90 different models of hydraulic valves are illustrated and described in New Catalog Section 202. 52 pages devoted to illustrating and describing nearly ever type of 4-way hydraulic valves offered in the industry. . . . Description of each model valve includes working drawings, specifications cut-away views, and operational diagrams of piston designs. Circuit layouts for important types of control show arrangement of all necessary hydraulic equipment, and are accompanied with description of circuit operation. Featured in the new catalog is the simplified Rivett design with a balanced type piston, "O" rings for sealing the stem and cover, and large passages for unrestricted flow. In addition to the above types, the new catalog describes 25 models of oil pilot valves for remote control of main 4-way valves. Valves for flow control, shut-off and deceleration, relief, sequence, unloading, and counter-balance are likewise shown.

98 MINIATURE BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Technical Bulletin No. 50 lists a full line of ground miniature bearings, including the only miniature Conrad (retainer) bearings manufactured in the U. S.

99 PIPING AND FITTINGS

Midwest Piping & Supply Co.—"Midwest" Piping Products—Catalog 48. 184 pages of technical information and prices on Welding Fittings, forged steel Flanges and Prefabricated Piping. A convenient handbook for the pressure and process piping industry; contains digests of pipe and fitting specifications, suggestions for piping design and welding, layout data, formulas, etc.

100 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—The latest engineering information on Thomas Flexible Couplings is contained in their Engineering Catalog, which shows their complete lines of single and double types of All Metal flexible couplings for heavy duty impulse loads such as Diesel driven compressors, as well as for smooth loads such as motor driven centrifugal pumps.

101 PUMPS AND SEPARATORS

Kraissl Co.—Catalog in looseleaf form giving data on the products that they manufacture. Data sheets are 8½ x 11 size and indicate as briefly as possible the important features of each product or item. The recent loose leaf additions to this catalog include the new Kraissl Class 23 Series Air Pumps for the printing and packaging machinery field, which require no oil lubrication. Other data sheets describe the complete line of Kraissl Separators including both strainers and filters which have been listed as standard by the Board of Fire Underwriters for fuel oil service, over a very wide range of pressures and pipe sizes.

102 VERTICAL BORING AND TURNING MACHINES

American Steel Foundries, King Machine Tool Div.—New 2-color Catalogs, fully illustrated containing complete description and specifications on "King" Vertical Boring and Turning Machines. Catalog K-1 covers machines sizes 30", 36", 42", Catalog K-2, sizes 52", 62", 72", Catalog K-3, sizes 84", 100", Catalog K-4, sizes 120", 144".

103 TRAPS FOR REMOVING WATER FROM COMPRESSED AIR

Armstrong Machine Works—Bulletin 202 dealing with three types of traps for removing water from compressed air. This 4-page bulletin explains the advantages and limitations of each type of trap and contains specific recommendations on traps for handling water contaminated with heavy oil and sludge; small amounts of clean water from high pressure air lines; and draining receivers, separators, and aftercoolers.

104 SPEED REDUCERS

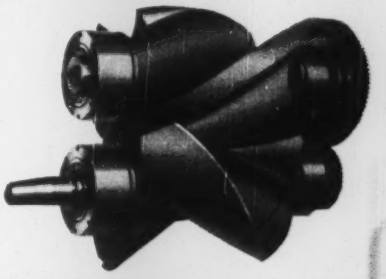
W. A. Jones Foundry & Machine Co.—Bulletin No. 68 covers the latest information on Jones Worm Gear Speed Reducers. Heavy duty machines are furnished in type "H" with worm below gear and in type "R" with worm above gear. They have horse-

Continued on Page 54

The STANDARDAIRE
PRECISION BUILT
Axial Flow BLOWER

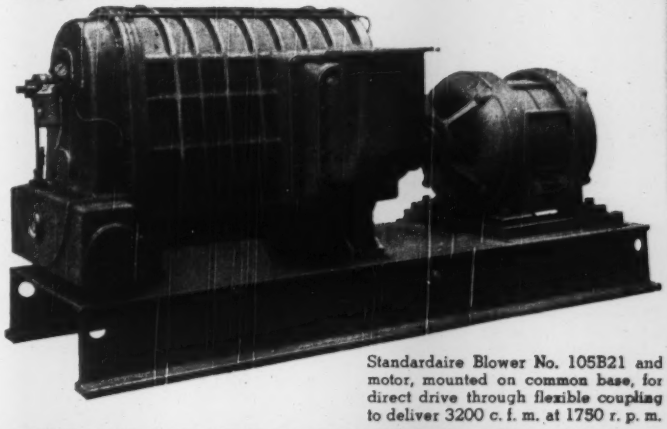
Features Two More Vital Components:

PRECISION ROLLER BEARINGS—spherical type are used on the fixed ends of the rotor shafts and a cylindrical type on the floating ends. With such a design free aligning action of the rotor shafts is assured and specific speed, load, and service requirements are easily met. In addition, this bearing construction fully compensates for any housing distortion which might occur due to temperature differentials.



LABYRINTH TYPE OIL SEALS—Bearings and gears are lubricated by a spray of filtered oil. The oil is controlled by a balanced pressure, labyrinth type seal which gives complete oil control and assures absolutely clean air delivery under all operating conditions.

Such features as precision bearings—frictionless oil seals—hardened, shaved, helical gears—contribute immeasurably to the efficient and dependable performance of the Standardaire Blower—A Modern Machine with Superior Operating Characteristics. For further information write The Standard Stoker Company, Inc. Dept. C-5, 370 Lexington Avenue, New York 17, N. Y.



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power ratings in accordance with the recommended practice of the American Gear Manufacturers Association.

105 ELECTRICALLY OPERATED VALVES

Ruggles-Klingemann Mfg. Co.—Catalog E on solenoid and motor operated valves has been revised to include many changes in design and improvements. Several new valves have been added to the already very complete line. The complete catalog M will, of course, include the revised catalog Section E.

106 ALL PURPOSE COPYING PROCESS

Ozalid, Div. of General Aniline & Film Corp.—4-page illustrated Folder briefly explaining the story of Ozalid . . . the modern, speedy way to copy anything typed, drawn, or written. Contains a graphic explanation of the process; complete machine specifications and descriptions; and a brief description of the type of sensitized materials available together with their recommended uses.

107 STEAM ENGINES

Soulé Steam Feed Works—Steam Engines, small, reversing valve. Soulé Steam Feed Works Booklet ME1 describes 16 HP twin steam engine, originally designed for sawmill carriage feed, but useful wherever variable speed, reversing valve engine of this capacity is required.

108 CLUTCHES AND POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Handy Bulletin on Power Transmission Control. Shows typical installation of Rockford Clutches and Power Take-Offs. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications. Every production engineer will find help in this handy bulletin when planning his new products.

109 SK EQUIPMENT

Schutte & Koerting Co.—New products list Folder, entitled "Index of SK Equipment and Descriptive Bulletins", lists SK products according to application and alphabetically, together with the numbered descriptive bulletin pertaining to each product.

110 HAND TRUCKS

Standard Pressed Steel Co.—Its new "Hallowell" Uni-Truk has unique, triple welded angle construction of the nose, which eliminates danger of ends of side bars tearing loose. The "Uni-Truk" is inexpensive, lightweight and well-balanced for nimble handling of all but the heaviest hand truck jobs. Details contained in attractive, new illustrated Bulletin No. 757.

111 STRAIN MEASUREMENT

Hathaway Instrument Co.—4 page Catalog Leaflet entitled "Dynamic Strain Analysis—General Considerations" outlines the elements necessary for a complete dynamic strain analysis laboratory and describes briefly strain gages, five types of strain gage amplifiers for dynamic work, and eight types of oscillographs suitable for recording 6 to 24 records simultaneously and covering a frequency response range from zero or static to 50,000 cycles per second. Hico 3-00-1.

112 BLAST CLEANING AND DUST CONTROL

Pangborn Corp.—The latest developments in blast cleaning or dust control in Bulletin 1200, "Pangborn's" Condensed Catalog. This complete bulletin is colorful, interesting, full of pictures and drawings to tell the full story of air and airless blast cleaning, hydro-sand blast, wet sand blast, accessories and dust control.

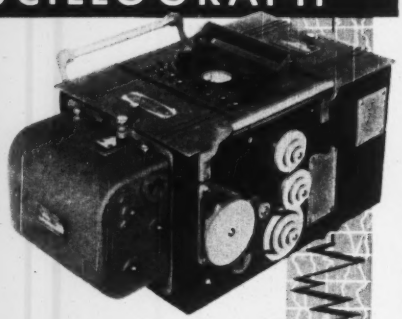
113 TURBINES — MECHANICAL DRIVE

Westinghouse Electric Corp.—2 recent Booklets describing the Westinghouse line of Type E General-Purpose Turbine. Booklet B-3896, "Westinghouse Type E Turbine," describes unique features of centerline support, interchangeable parts, dual protection in reduced maintenance of these turbines which are available in 16-, 20-, and 25-inch wheel sizes, for applications from 5 hp through 1500 hp. Booklet B-4346, "Westinghouse Gearturbines," presents a line of close coupled geared turbine units, combining the Westinghouse Type E Turbine with a rugged, compact, speed reduction unit solidly coupled on a

THE NEW

'Economy' OSCILLOGRAPH

Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.



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unique combination oil reservoir and base. Important features such as dual overspeed protection, weather and dirt-proof bearing seals, centerline supports and free expansion, single-helical gearing, three-point support for ease in leveling and aligning and maintenance-saving refinements are explained in detail.

114 SYNTRON EQUIPMENT

Syntron Co.—New 44-page Catalog—convenient small size—illustrating and describing the entire line of "Syntron" Equipment—Vibratory Handling Equipment, Portable Power Tools, Diesel Power Hammers, Test Sieve Shakers, Selenium Rectifiers, Shaft Seals, Vibrating Paper Joggers, and Concrete Vibrators.

115 LIQUID METERS

Neptune Meter Co.—20-page Technical Bulletin No. 566 covers Trident positive displacement liquid meters noted for sustained accuracy in industrial applications. Includes Auto-Stop meters for automatic batching, meters for inventory, for measuring interdepartmental demand, etc., of 100 or more industrial liquids ranging from water to liquid sugar and vinyl lacquer. Selection tables, specifications, typical applications.

116 AUTOMATIC CONTROL SYSTEM

Taylor Instrument Cos.—New system greatly reduces panel costs, gives increased quality control and provides more suitable means for supervision of a process to detect variations in control conditions. Includes latest development in stacked-diaphragm force-balance controllers—the "Transet Tri-Act" Controller; "Transaire" Temperature and Pressure Transmitters; miniature Indicating and Recording-Receivers. Described in Bulletin No. 98097.

117 INDUSTRIAL SCALES

Toledo Scale Co.—40-page Catalog containing data, illustrations and descriptive matter on many types of industrial scales used for weighing, counting, computing, batching, packing, weight-printing, force-measuring and other applications throughout modern industry. Pages of catalog are indexed for easy reference.

118 PYROMETERS

Leeds & Northrup Co.—Micromax and all other L&N plant instruments for measuring, recording and controlling temperatures detected by thermocouples are described in Catalog N-33A. Temperature instruments for use with Rayotubes are described in Catalog N-33B. For information on high-speed Speedomax Recorders for industrial temperatures, see Catalog ND46. Complete equipment for checking thermocouple pyrometers is listed in Catalog E-33A-503.

119 ELECTRIC MOTORS

Howell Electric Motors Co.—"Red Band" Motors customers' price Catalog available and also descriptive bulletins separately describing motor types including general purpose squirrel cage induction motors totally enclosed, elevator motors, explosion-proof, multi-speed and sanitary motors and also a bulletin on fractional horsepower ratings. Also condensed price sheets and bulletins AC-2 are available, the latter listing recommendations for various types of motors used on typical applications. The Company specializes in industrial A. C. Motors from 1/4 to 150 horsepower.

120 AIR PREHEATERS

Air Preheater Corp.—First section of Catalog on Ljungstrom Air Preheaters presents an over-all picture of the Ljungstrom; its functions and operation. Examples of installations of the Ljungstrom continuous counterflow regenerative type preheater, covering a range of diverse applications, are shown in diagrammatic form, together with photographs of the Ljungstrom in sufficient detail to make its principle and operation clear.

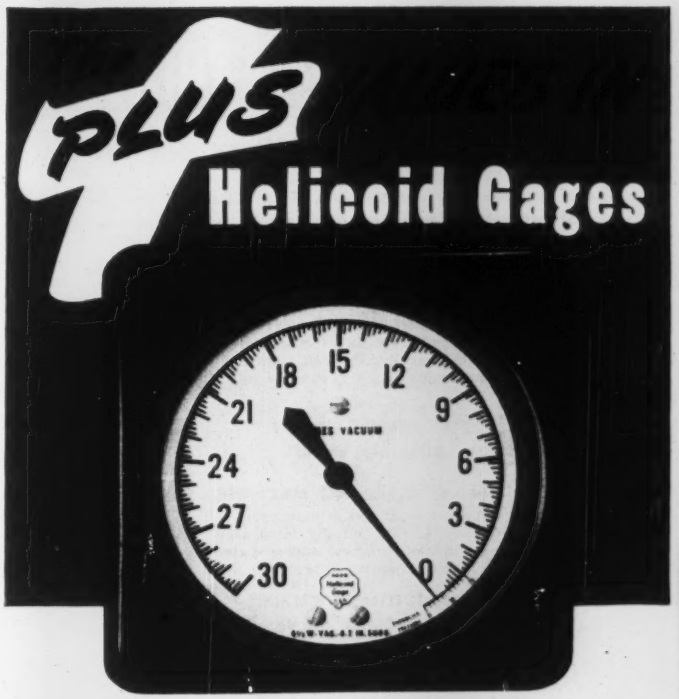
121 CRUSHERS

American Pulverizer Co.—Bulletin illustrates and describes in detail complete line of custom-built Crushers, Grinders, Shredders and Choppers for uniform reduction. Includes cut-away and cross sectional views as well as engineering data and specifications.

122 PROCESS EQUIPMENT AND STEAM GENERATORS

Union Iron Works—Bulletin 124 describes Union Dowtherm Vaporizers designed and built 250,000 BTU/Hr. to 30,000,000 BTU/Hr. at 750° capacity to applicable construction codes. Gas, oil or fuel fired or designed for special fuels. Dimension tables, general and specific property tables, and applications are included in this bulletin. Special bulletins on 13 basic designs of Union Boilers are also available.

Continued on Page 56

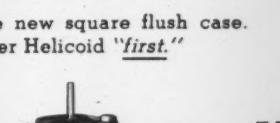


This Vacuum Gage is an example of the extra value at no extra cost in all HELICOID GAGES.

Note:

1. Dial in inches of mercury vacuum, reading counter clockwise, to denote negative pressure and prevent confusion with a 30 lb. pressure gage.
2. Subdivisions in graduated steps of 0.2 inches for ease in reading scale.
3. Hairline Pointer adjuster to correct zero setting for changes in barometric pressure.
4. Guaranteed accuracy to within 0.15".
5. The new square flush case.

Another Helicoid *"first."*



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

TRADE MARK

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

CUT PRODUCTION and MAINTENANCE COSTS

with FACTORY-ASSEMBLED Pangborn UNITS!

These inexpensive, ready-to-use Blast Cleaning and Dust Collecting units earn you extra profits where custom-built equipment is not practical.

BLAST CLEANING CABINET
cleans metal parts, removes rust, scale, grime, dirt, paint, etc., in a few seconds. Ideal unit for producing clean, smooth surface on pieces up to 60" x 36".

BLAST CLEANING CABINETS
$315.00 and UP

BLAST CLEANING MACHINE
for maintenance and many other uses including the removal of rust, dirt, scale, etc. Economically cleans large objects such as tanks, bridges, structural work preparatory to painting. Six sizes, stationary or portable.

BLAST CLEANING MACHINES
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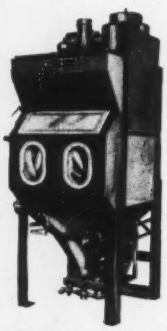
UNIT DUST COLLECTOR
traps dust at its source, minimizes machine breakdowns, reduces housekeeping and maintenance costs. Solves many grinding and polishing nuisances and material losses.

UNIT DUST COLLECTORS
$286.00 and UP



HYDRO-FINISH CABINET
uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001".

HYDRO-FINISH CABINETS
$1295.00 and UP

MAIL COUPON TODAY!

Look to Pangborn for the Latest Developments in Dust Control and Blast Cleaning Equipment

PANGBORN CORP., 3200 Pangborn Blvd., Hagerstown, Md.
Gentlemen: Please send me further information on—

☐ BLAST CLEANING CABINETS
☐ BLAST CLEANING MACHINES
☐ UNIT DUST COLLECTORS
☐ HYDRO-FINISH CABINETS

I am interested in the possibility of using one of these machines for.....

.....

NAME.....

COMPANY.....

ADDRESS.....

CITY.....**STATE**.....

Pangborn

123 REFRIGERATION CONDENSERS

Henry Vogt Machine Co.—New Bulletin RC-1 covering Vogt Refrigeration Condensers. The proper selection and correct operation of the condenser greatly influences the cost of refrigeration. This bulletin shows types and sizes of condensers which will best meet particular operating conditions.

124 POWER PRESSES—INCLINABLE, HORNING STRAIGHT SIDE

V & O Press Co.—Catalog available describing Inclinable Presses, Bench Presses, Double Action Presses, Punch Presses, Arch Presses, Horning and Wiring Presses, Reducing Presses, Foot Presses, Notching Presses, High Speed Presses, Straight Sided Presses; Automatic Roll Feeds, Dial Feeds; Feed-O-Matic (Punch Press Feeder); Automatic Threading and Trimming Machines.

125 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—New 35-page Hyatt Handbook "Guide Lines for Engineers and Designers". A guide to the proper application of cylindrical roller bearings in machinery and equipment of all types. With design drawings of successful, tested applications, illustrating the fundamental needs which must be provided for in the machine designed: namely—retainment, shaft location, housing, lubrication seals and closures.

126 SEAMLESS WELDING FITTINGS AND FORGED STEEL FLANGES

Tube Turns, Inc.—Chart of Pipe and Fittings Materials. Quick-reference chart covering ASTM and other specifications, Chemistry, Service Temperature Limits and Welding Data on carbon, intermediate alloy, stainless and special analysis steels, Dimensional Data and Weights. Folder of man-size tables giving dimensional information on Tube-Turn welding fittings from $^1/_2$" to 30" in standard weight and extra strong, and flanges in all sizes and weights. Allowable Working Pressures. Booklet of pressure tables covering complete line Tube-Turn welding fittings for Power Piping, Oil Piping, Heating Piping, Gas Piping, Refrigeration Piping.

127 CENTRIFUGAL, RECIPROCATING, ROTARY AND SCREW PUMPS

Warren Steam Pump Co.—Bulletins available covering centrifugal pumps, single and multistage; pressure range to 1200 p.s.i., capacities to 50,000 G.P.M., horizontal and vertical types, open or enclosed impellers. Also, bulletins covering reciprocating pumps, horizontal and vertical single and duplex piston, single and duplex plunger, single, duplex and compound hydraulic, steam heat vacuum, automatic pump and receiver, Quimby rotary and screw pumps.

128 AIR-COOLED ENGINES

Wisconsin Motor Corp.—56-page delux Catalog, printed 2 colors, illustrating and describing factory production processes of engines in detail, with 146 illustrations and captions covering a great variety of engine power applications in many fields, illustrations of full line of engines, 2 to 30 hp., with brief specifications, general data, and list of Wisconsin distributors by states.

129 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 12-page Catalog, illustrated with comprehensive specifications on more than 70 types and sizes of standard miniature ball bearings from 2 mm to $^1/_{16}$" outside diameter. Includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

130 OIL FILTERS AND OILING DEVICES

Wm. W. Nugent & Co.—A set of six Bulletins in a binder. Each bulletin profusely illustrates and describes a Nugent product such as: Gravity Liquid Filters; Pressure Liquid Filters; Oiling Devices; Sight Feed Valves; Sight Flow Indicators; Compression Union Pipe Fittings; Automatic Oil and Water Separating Tanks; Oiling and Filtering Systems. These products are for large Engines, Pumps, Compressors, Gear Reduction Units, etc., and all kinds of machinery used in Rolling Mills, Cement Mills, Power Plants, both Stationary and Marine, and Railroads.

131 TECHNICAL BOOKS

John Wiley & Sons—Publishers of scientific and technical books. 1951 Catalog available, containing descriptions of over 1300 books in science and engineering. Of particular interest to engineers are the following recently published Wiley titles: Kent's "Mechanical Engineers' Handbook", 12th edition—Power volume, edited by Salisbury—Design and Production volume, edited by Carmichael; Hetenyi's "Handbook of Experimental Stress Analysis", Salisbury's "Steam Turbines and Their Cycles", Eckman's "Industrial Instrumentation", and Brown's "Unit Operations".

132 WALVECTOR RADIATION

Warren Webster & Co.—Bulletin B-1551 describes the new idea in wall radiation. Elongated, nonferrous convector. Heating element is copper tubing with aluminum fins. Light weight, high output. Four types of enclosures for mounting along outside wall close to floor or under windows. For wall to wall application or use as separate convectors. For steam or hot water heating.

133 CHAIN DRIVES

Morse Chain Co.—Packed with 32 pages of illustration and information, new Catalog C71-48 offers complete data on famous Morse Silent Chain. Features are: assembly and disassembly; explanation of the exclusive "Rocker Joint"; service factors; stock sprocket data; drive design; selection tables; installation and maintenance; and many other important topics.

134 DEEP DRAWING PROCESS

Hydropress, Inc.—Folder describing "Marform" which is a new precision Deep Drawing Process developed by the Glenn Martin Co., Baltimore, Md. Deeper draws than heretofore in one operation, reduced tool costs, economical production regardless of quantities are only a few of the advantages. Marform units can be adapted as well to new equipment as to existing installations.

135 GRATING—FLOORING, SAFETY TREADS

Irving Subway Grating Co.—Catalog No. F-225 contains illustrations, descriptions and engineering data on fireproof, durable, safe, clean and economical Gratings and Safety Steps (riveted, pressure-locked and welded) for Industrial Plants, Power Plants, Refineries, Ships, Railroad Freight and Passenger Cars and Locomotives, Open Steel-Mesh Bridge Decking, etc.

136 MARINE PROPULSION UNITS

Western Gear Works—Bulletin 5070 describes the Pacific-Western line of marine planetary propulsion gears for engines developing over 600 HP, and extending as high as 50,000 HP in a single unit. Any reduction can be supplied. For ratios between 1.7 to 1 and 2.3 to 1, the spiral bevel type planetary unit is provided; for other ratios the helical gear is supplied. Bulletin outlines space and weight saving advantages of this highly efficient type of gearing.

137 KEY TO REMOTE CONTROL

Automotive & Aircraft Div., American Chain & Cable Co.—Booklet "The Key to Remote Control." Tru-Lay Push-Pull Controls. Built as precise machine parts for handling push or pull loads from 30 to 1,000 lbs. Quality controls of long life. Operative in extreme low temperatures as well as normal temperatures. Standard parts available for making most installations with the exception of length which can be varied. Suitable for use in extreme long lengths.

138 BUCKET ELEVATOR EQUIPMENT

Beaumont Birch Co.—New Catalog No. 10-B illustrates and describes Beaumont Beaucalloy Chains, "Uni-Cast" Buckets and "Trac-Pull" Traction Wheels. Made of special steel alloy, these Beaucalloy products give exceptionally long service in handling all types of bulk materials—sticky, abrasive, or hot. Maintenance costs have been cut in half through use of this equipment. Beaucalloy products are guaranteed by the manufacturer. Patents pending.

139 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in loose-leaf form which cover a complete description of Terry solid wheel turbines with cross-section drawings of typical units for both moderate and high steam pressure conditions, a description of the Terry axial flow impulse, both singlestage and multistage. Terry gears are used for speed increasing and speed reducing.

140 SPUN END PROCESS

Wolverine Tube Div., Calumet & Hecla Cons. Copper Co.—Brochure describing the distinctive Spun End Process. In 28 pages it tells a concise story of a revolutionary metal-forming process that is highly efficient and relatively inexpensive. A quick comprehension of the process is gained through the many photographs, diagrams and descriptions that make comparisons between the old and the new methods.

141 O-RINGS

Linear, Inc.—Compact 6-page Folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes give general recommendations on clearances, design, material, machining and finishes for most O-ring applications.

Continued on Page 58

METAL PLANT

owner estimates savings of $7690 per year with Pangborn Dust Control.

ASBESTOS PRODUCER

reports profit of $20 a day with Pangborn Dust Control.

FOOD PROCESSOR

writes Pangborn Dust Control saves him $3048 per year.

CARBON PRODUCER

reports $1471 yearly profit with Pangborn Dust Control.

CHEMICAL MFGR.

states Pangborn Dust Control saves him $14,859 a year.

FEED MILLER

reports approximately $50 saved each day with Pangborn Dust Control.

WOOD FABRICATOR

estimates $875 saved every year with Pangborn Dust Control.

REFRACTORY

executive reports savings of $4318 per year with Pangborn Dust Control.

RUBBER PLANT

owner reports $100 profit each month with Pangborn Dust Control.

CHARCOAL MFGR.

estimates yearly saving of $13,900 with Pangborn Dust Control.

WHICH DUST PROBLEM BOTHERS YOU ?

READ HOW PANGBORN DUST CONTROL STOPS DUST PROBLEMS LIKE THESE— ***at a profit!***

As these authentic cases from Pangborn's files show, Pangborn Dust Control stops dust at a profit! Even where dust can't be sold or re-used, Pangborn users report impressive savings from $1200 to $7000 and more a year.

And where dust is valuable (made up of products or raw materials), annual savings of $12,000, $13,000 or $14,000 a year are not uncommon for Pangborn installations.

FIND OUT HOW MUCH YOU CAN SAVE! A Pangborn Dust Survey costs nothing—but will show you how you can *turn the dust in your plant* into cash savings. For details, write the PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Maryland.

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning Equipment.

STOP the DUST HOG from stealing profits with

Pangborn

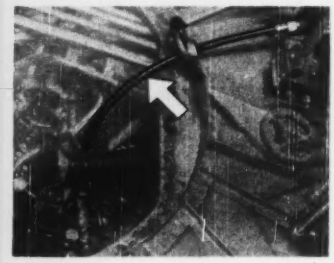
DUST CONTROL

LOOK WHAT YOU CAN DO WITH S.S.WHITE FLEXIBLE SHAFTS

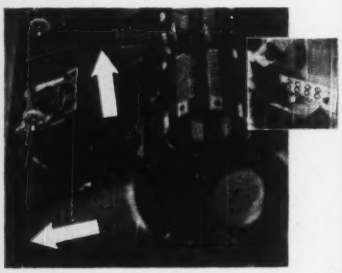
Engineers will find many valuable uses for S.S.White flexible shafts in equipment design. Some cases in point are shown at the right. These smooth operating, readily adaptable mechanical elements come in a wide range of diameters and characteristics in both the power drive and remote control types. They can be supplied to your specific length requirements.

FLEXIBLE SHAFT FACTS
BULLETIN 5008—just off the press—gives the latest information and data about flexible shafts and their application. Write for a copy today.

REMOTE CONTROL of an inaccessible part can be accomplished with a single flexible shaft, as in the case of this rotary switch.



POWER DRIVE. Power can be taken from one point and delivered to another with an easily applied flexible shaft combination. That's how this aircraft tachometer generator is driven.



CENTRALIZING CONTROLS. Control knobs can be readily grouped for convenient operation and more orderly arrangement when you use flexible shafts to couple the knobs to the parts they control. This broadcast transmitter is a good example of how it's done.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. L, 10 East 40th St.
NEW YORK 16, N. Y.

A special compound bulletin containing descriptions of the latest polymers and synthetic rubbers from which O-rings can be moulded is also included.

142 POWER CHUCKING EQUIPMENT

Cushman Chuck Co.—New Catalog No. PO-64, completely revised catalog-databook listing complete lines of Cushman Air Operated Power Chucks, Rotating Air Cylinders and accessory equipment. New Cushman Aluminum Body Rotating Air Cylinders and Aluminum Body Chucks for high speed operation fully described and illustrated. Also contains dimension drawings and tables of air cylinders and chucks and parts lists.

143 SAFETY AND RELIEF VALVES

Kunkle Valve Co.—Catalog No. 49, 34 pages. Well illustrated views and cross sections. Complete specifications. Capacities, body and trim metals, dimensions, weights, service recommendations, etc., are given. ASME tested, National Board Certified and Navy Approved Types of safety and relief valves are completely described so that selection and specifications for use are more easily made.

144 SPIRAL-WOUND GASKETS

Flexitallic Gasket Co.—Folder contains illustrations, descriptions and engineering data on nine basic styles of spiral-wound gaskets for pipe flanges, pressure vessels and process equipment for all standard A.S.A. and A.P.I. fittings. New CG-1 "compression gauge" type gasket with inner and outer stainless steel ring is described. Data included on special gaskets.

145 ROLLER CHAIN FLEXIBLE COUPLINGS

Baldwin-Duckworth Div., Chain Belt Co.—New illustrated 12-Page Catalog giving complete data on roller chain couplings and how to select them, and on coupling covers and their advantages. Also contains specification data with many tables and charts on permissible angular and radial misalignments, tables on bore tolerances, etc.

146 DUST COLLECTORS

Fly Ash Arrestor Corp.—The cyclonic separation principle applied in a new and practical manner pictured in our new Bulletin, "Guided Inlet Cy-

The Latest Industrial Literature

offered in this list represents recently issued Catalogs, Bulletins, Handbooks, Data, Booklets, Charts, Informative Folders and other engineering information made available by current advertisers in ASME Publications.

clones". Bulletin describes construction, application, and operation of this versatile dust collector and points out new features designed to give higher collection efficiencies on ultra fine dusts with reasonable draft losses.

147 ASH CONVEYORS

National Conveyors Co.—New 8-page Catalog is offered as a guide to assist in selecting the right type of steam pneumatic ash system for plants. A section is devoted to the description and illustration of special rotary feeds, cut-off valves, and furnace doors. In addition, the catalog contains information on systems for crushing, conveying and storing of metal turnings, and oil reclamation systems for metal working plants. See advertisement in ASME Mechanical Catalog and Directory, page 225.

148 VALVES, BOILER MOUNTINGS AND LUBRICATING DEVICES

Lunkenheimer Co.—Complete Lunkenheimer Guide, circular No. 555, for selecting valves, boiler mountings and lubricating devices. This guide with thumb index for easily finding desired sections contains descriptions and specifications, all completely illustrated. Valves are grouped according to steam pressure (S. P.) ratings. Pages 1 to 15 illustrate regular valves, grouped according to pressure, as shown by the thumb index. Pages 10 and 11 illustrate the application of Lunkenheimer Boiler Mountings conforming to the ASME Boiler Code. The remainder of the guide illustrates other valves and products according to class of service or class of product.

149 PORTABLE GAS ANALYZERS

Ellison Draft Gage Co.—Bulletin 120 describes the function and application of gas analyzers, details the construction and pictures unit from various angles. These units are designed and constructed for convenient measuring CO_2, O_2, and CO in flues, stacks, exhausts, mines and other places where these gases may be present.

150 THERMOSTATIC BIMETAL

W. M. Chace Co.—64 page Reference Manual to aid engineers in design of actuating elements for temperature responsive devices. Contains applications of Chace Thermostatic Bimetal, elements of thermostat design, proper heat treatment for bimetal, various formulae and circulations, descriptions of 30 bimetals with 30 full page charts and data describing physical properties of each bimetal.

151 BALL BEARING SWIVEL JOINTS

Chiksan Co.—48 page Catalog No. 50 illustrates and describes complete line of over 500 different Types, Styles and Sizes, with data on working pressures, maximum temperatures, dimensions and weights. 12-page Catalog No. 2A gives data on Aircraft-Hydraulic Swivel Joints for pressures from 1,000 psi to 3,000 psi.

152 IMPROVING METALS BY FORGING

Steel Improvement & Forge Co.—44 page informative Catalog on shaping and improving metals by forging. Shows pictures of methods used, including designing, die sinking, drop forging, heat treating, and inspection for quality control. Contains tables of the characteristics and applications of commercial forging metals, and standard tolerances for drop forgings.

153 BALL AND ROLLER BEARINGS

Aetna Ball & Roller Bearing Co.—Latest 52 page Catalog gives specifications on Aetna's full line of standard ball thrust bearings, clutch release bearings, ball retainers and hardened and ground washers. Contains helpful technical data for design engineers, useful calculations and formulae, important application principles, fundamentals of proper lubrication, bearing selection and care. Shows the wide variety of special bearings and precision parts falling within the scope of Aetna facilities. Full line includes standard and special ball thrust bearings . . . angular contact ball bearings . . . special roller bearings . . . ball retainers . . . hardened and ground washers . . . sleeves . . . bushings.

154 STEEL VALVES

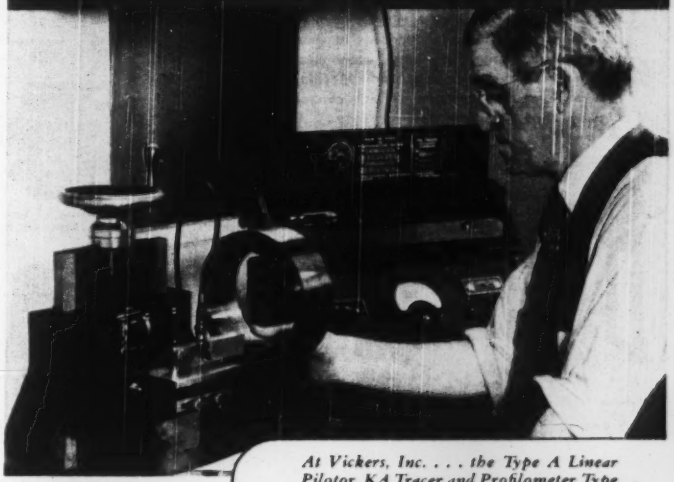
Lunkenheimer Co.—68 page Booklet No. 553, describing the complete Lunkenheimer line in steel valves. Arranged according to figure number index and design selection index with specifications. Booklet completely illustrated to include the finished product and drawing of cross section of finished product. Is arranged to facilitate selection of the proper types of steel valves, and to give as much information as possible concerning that particular steel valve.

155 PUMP DRIVES

Western Gear Works—Bulletin 4907 describes in detail the new Pacific-Western line of right angle

Continued on Page 60

Unequalled Versatility
in Surface Roughness Measurement



At Vickers, Inc. . . . the Type A Linear Pilotor, KA Tracer and Profilometer Type Q Amplimeter in use.

when the PROFILOMETER is used

You can take almost any part, regardless of its shape, area, or surface finish, and quickly secure *accurate* meter readings of its surface roughness when you use the Profilometer.

To meet your specific roughness rating requirements, a wide variety of standard Profilometer tracing and piloting equipment is available. Manually operated Profilometer tracers are generally used for their speed and all-around convenience. In addition, manual tracing offers advantages by providing ratings for surfaces that cannot otherwise be measured—such as pieces on large boring mills, out-of-the-way bearing surfaces on large castings, and surfaces up to several feet in length.

Profilometer equipment such as that illustrated above is supplied for mechanical tracing and is most practical for providing short tracing strokes and on extra smooth surfaces where a steady, vibration-free tracing motion with smooth reversals is required for greatest accuracy. Mechanical tracing also permits the use of tracers without supporting skids for entering small holes and other hard-to-reach surfaces; Pilotors can also be furnished to provide the motion for tracing in circular arcs and complete circles.

Complete information on all standard Profilometer equipment—the most extensive line of roughness-measuring equipment available to industry today—is yours for the asking.

WRITE FOR FREE BULLETINS L-6 and L-11.

Profilometer is a registered trade name.

PRC

PHYSICISTS RESEARCH COMPANY

Instrument Manufacturers

ANN ARBOR 6 • MICHIGAN

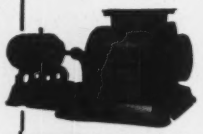
FROM POUNDAGE to HIGH TONNAGE

AMERICANS Offer . . .

***Precise* Reduction**

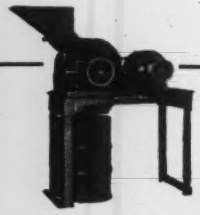
From small capacity laboratory mills to high tonnage mills, you can count on Americans to give dependable *uniform* sizing, and long, economical service. Americans are *custom-built* to handle specific reduction jobs better—your assurance of high efficiency, low-cost operation.

"30" Series Hammermill. Capacities to 100 TPH.



"24" Series—ring or hammer crushers. Capacities to 50 TPH.

Laboratory Mill—or testing, pilot plant operation—and waste reduction.



"KC" Plastics Grindar—reduces thermoplastic sprues, rejects. Capacities to 450 lbs. per hour.

"AC" Ring Mill. With American's exclusive shredder rings—for high tonnage, uniform reduction. 500 TPH capacity.

Write for complete information on the American line of crushers

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1541 Macklind Ave. St. Louis 10, Mo.

Small Capacity • Medium Duty

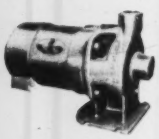
SIDE SUCTION PUMPS

Close-Coupled • **Flexible Coupling** • **Belt Drive**

CAPS 5 to 75 G.P.M.

HEADS 0 to 100 ft.

Ideal as part of Equipment Manufacturer's product, such as, air conditioning units, cooling towers, evaporator coolers, milk coolers, hot water circulators, etc. — and general service. Speeds 1750 to 3500 R.P.M.



Type JMC Aurora Close-Coupled Pump

DISTRIBUTORS IN PRINCIPAL CITIES

Aurora Always Pumps

AURORA PUMP COMPANY

96 LOUCKS STREET AURORA, ILLINOIS

vertical pump drives. This line of drives is available for speed increaser, no speed change, or speed reducer requirement. Flexibility in design details is maintained to suit customer needs for specific applications. These drives are available in a wide range of power and speed requirements, including all sizes larger than 200 rated horsepower at 1:1 ratio and 720 RPM.

156 MULTITHERM UNITS

Clarage Fan Co.—Bulletin No. 1307, Clarage Multitherm Unit for vital industrial air conditioning services. Types to furnish cooling only, heating only, or year-round control of temperature and humidity quickly installed—no building alterations or elaborate duct system required. Used to speed production. Large range of sizes.

157 COOLING TOWERS AND DRICOOLERS

Marley Co.—Bulletin G-51 describes entire line of Marley water cooling equipment, from spray nozzles and spray ponds to natural and mechanical draft cooling towers of all sizes. Bulletin DC-50, on dry surface cooling equipment, gives engineering data and ratings on three new small-size Marley DriCoolers and describes the larger units.

158 MECHANICAL SEALS

Peerless Pump Div., Food Machinery & Chemical Corp.—Bulletin B-595, describes complete line of Mechanical Seals in three types: General Service for ordinary liquids, Abrasive resistant for liquids containing abrasives, and Special Seals for applications in corrosive liquid service. Designed for pumps and rotative shaft equipment.

159 UNIT HEATERS, FANS, BLOWERS, TURBINES

L. J. Wing Mfg. Co.—Individual Bulletins may be had as follows: HR-5, Revolving Unit Heaters; TH-2, Turbine Unit Heaters; GH-1, Gas-Fired Unit Heaters; U-7, Utility Unit Heaters; HS-3, Heater Sections; F-11, Ventilating and Duct Fans; TC-1, Transformer Cooling Fans; SH-1, Shutters and Penthouses; SW-50, Forced Draft Blowers and Turbines; I-49 Draft Inducers; SV-3A, Ship ventilators.

160 MICROHONING

Micromatic Hone Corp.—4-page, bi-monthly Bulletin "Cross Hatch" describing and illustrating the principles of the Microhoning process. Currently new applications and equipment design are shown with complete details.

161 ACTUATING CYLINDERS

Ledeen Manufacturing Co.—Bulletin No. 500 illustrates and describes complete line of actuating cylinders for air, oil, water or steam operation. Bulletin shows detailed features, reasons for selecting medium duty, heavy duty or super-duty cylinders; dimensions and weights, ratings and limitations; rod and head attachments, and complete specifications. Bulletin is valuable guide to engineers, designers, maintenance men and others whose equipment must push or pull, lift or lower, press or squeeze, tilt or turn, open or close.

162 VACUUM CLEANERS

U. S. Hoffman Machinery Corp., Air Appliance Div.—6 New Bulletins—5 describing each of the 5 sizes of new Hoffco-Vac industrial portables in the complete Hoffman line. Bulletin A-814 covers the 1½ h.p. Hoffco-Vac 15. Bulletin A-732 for the 3 h.p. Hoffco-Vac 30. Bulletin A-794 for the 5 h.p. Hoffco-Vac 50; Bulletin A-803 for the gasoline engine operated 5 h.p. Hoffco-Vac 50; and Bulletin A-819 for the 7½ h.p. Hoffco-Vac 75. A sixth bulletin A-816 describes design and operating advantages of Hoffman stationary vacuum cleaning systems.

163 WEAR RESISTANT METALS

Carboloy Co.—Reprint of an article entitled "What Are Carbides Good For?" dealing with properties of ultra-hard wear-resistant carbide metals, together with illustrated examples of their use to eliminate wear at critical points in typical mechanical products. Also includes brief review of their use for cutting tools, sheet metal dies, etc.

164 CAST IRON PULLEYS

W. A. Jones Foundry & Machine Co.—Catalog No. 83, shows standard as well as special pulleys, contains engineering data to help you with your design problems and complete price information on all types of standard pulleys.

165 AUTOMATIC SPEED CONTROL

Boulin Instrument Corp.—4-page Bulletin describes and illustrates a new Stationary Tachometer with Electronic relay for use either as a safety or a control device. These units are used to closely control the speed of blowers, centrifuges, compressors, conveyors, pumps, pulverizers and turbines as well as

surface speeds of cloth, metal, paper, plastics and wire. As a safety device they operate a bell or flash a light, close remotely controlled valves, throw load on generators or stop machinery at predetermined speeds.

166 EXTENDED SURFACE

David E. Kennedy, Inc.—Catalog D-21, complete performance data is available for heat transfer and pressure drop on the finside. Chart also available showing range of sizes and combinations of fin heights, thicknesses, and rows of fins per inch. Above data covers both ferrous and non-ferrous tubing as well as fins welded to the tube and fins soldered to the tube.

167 BOILERS AND STOKERS

James Leffel & Co.—Bulletin 236, 28 pages and cover, lists, illustrates, shows cutaway views and gives details of Leffel Scotch Marine Boilers and Leffel Underfeed Stokers. Includes boilers of six to 250 HP, all built to ASME Boiler Code. Coal, gas and oil fired, quickly convertible. Stoker exclusively for use with Scotch Marine Boilers.

168 TEMPERATURE CONTROLLERS

Foxboro Co.—Bulletin 225 presents in 40 illustrated pages the pneumatic temperature controllers included in the very extensive line of Foxboro Instruments, pneumatic, electric and electronic. Other bulletins cover such individual subjects as indicating, recording and controlling instruments of various types, or instrumentation for specific applications. Correspondence is invited on any phase of instrument engineering involving temperature, pressure, flow, liquid level, humidity, pH, density, conductivity, speed, weight and force, etc., control valves, instrument panels, or complete control systems.

169 BROACHING MACHINES, PRESSES

Oilgear Co.—Bulletin No. 10052, contains complete specifications and condensed information on their standard line of Fluid Power Broaching Machines and Presses, illustrates and describes diversified special machines and lists the fluid power components manufactured for direct and resale purposes.

170 EXPANSION JOINTS

Badger Manufacturing Co.—New Catalog describing the complete line of Badger "Packless" corrugated expansion joints, is now available. Complete tables of dimensions for both non-equalizing and directed-flexing self-equalizing joint, line thrusts on anchors at various pressures, and the allowable movements when expansion joints are required to care for both axial and lateral motion.

171 AUTOMATIC REGULATING VALVES

Klipfel Valves, Inc., Div. of Hamilton-Thomas Corp.—New composite Catalog of automatic regulating valves includes sections on Float Valves, Reducing Valves, Tank Thermostats and Back Pressure Valves.

172 METAL WORKING PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—New Catalog Sheets list completely a wide range of metal-working punches and dies carried in stock for immediate shipment. Styles to fit most makes of hand, foot and power operated punch presses are standard. Hand-operated punches, cutters, and benders are also illustrated and described.

173 TUBULAR ELECTRIC HEATERS

Martin-Quaid Co., Hynes Electric Heating & Process Div.—Bulletin No. 201 just released provides complete descriptive and engineering data on Hynes Tubular Electric Heaters for heating liquids in all types of tanks and pressure vessels. Included is a Table of Heat Density Ranges and a Table of Suggested Heat Densities for various fluids. Profusely illustrated throughout, this Bulletin has drawings and photographs showing methods of installation for horizontal, vertical, open and closed tanks. Also outlined are the important engineering considerations in the application of electric heat to all fluids.

174 HYDRAULIC TURBINES

James Leffel & Co.—Pocket-size Bulletin 36, 32 pages, shows and briefly describes a large variety of hydraulic turbines and accessory equipment made and supplied by Leffel. Has a great many cutaway views of installations, showing method of installation of different type Leffel turbines under various conditions. Single-page special bulletins are issued from time to time.

175 STEAM GENERATORS AND FURNACES

Petro-Chem Development Co.—Two Technical Bulletins: 50-1 and 50-2, which describe and illus-

Continued on Page 63

Multi-Purpose *Thermostat* Controls 90 psi Steam Pressure within ±4 psi

When cold water is changed into scalding steam in two minutes, it is of primary importance to solve the problem of turning off the fire and fuel before safety valve pressure is reached. This was accomplished for Quick Charge Inc. — makers of a portable steam generator — by a Fenwal THERMOSWITCH unit. The sensitive, dependable thermal response of this rugged thermostat makes possible the maintenance of a 90-pound per square inch pressure within plus or minus 4 psi when set at 320°F.

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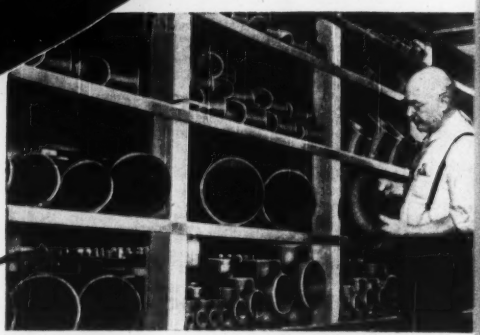

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trate Iso-Flow Steam Generators and Iso-Flow Furnaces. Bulletin 50-2 contains a detailed summary of the design and operating characteristics and operating test data on a 30,000 lb. per hr. Iso-Flow Steam Generator installation. Bulletin 50-1 describes and illustrates the Petro-Chem Iso-Flow Furnace, Radiant Convection Design, and includes the significant design and operating characteristics of these cylindrical furnaces which are in extensive use throughout the petroleum, chemical and allied industries.

176 VIBRATION FATIGUE TESTER WITH THYMOTROL DRIVE

All American Tool & Mfg. Co.—Bulletin 100 HA-T describes vibration fatigue tester which provides smooth, stepless acceleration from 10 to 100 cycles per second by means of G-E Thymotrol electronic drive. Parts up to 100 lbs. in weight can be tested. Table movement is horizontal. Max. capacity is 23 g.

177 FLUID POWER EQUIPMENT

Oilgear Co.—New 8-page Bulletin 10051-A illustrating and describing their complete line of Fluid Power Pumps, Motors, Transmissions, Cylinders and Valves. It features a new line of small constant and variable delivery pumps . . . a new line of axial piston motors . . . an improved line of standard cylinders for pressures up to 1500 psi and a new line of heavy-duty cylinders for pressures up to 3000 psi. It introduces their standard line of pilot and directional control valves, relief and foot valves, surge (pre-fill) valves, combination valves, differential valves and auxiliary fluid equipment for pressures up to 3000 psi.

178 STEAM GENERATORS

Cyclotherm Corp.—The efficiency of any steam generator is dependent upon the rate of heat transfer from fuel to useful heat. Catalog S-1 describes in detail the exclusive, patented, Cyclotherm principle of combustion and heat transfer, and gives detailed Engineering data and charts on all of the Cyclotherm Package Type Generators available to industry.

179 WORM GEAR SPEED REDUCERS

Cleveland Worm & Gear Co.—Bulletin "Dependable Through 38 Years"—presenting a series of case studies of Cleveland drives in various industries. Included are the company's "Speedaire" fan-cooled units, standard horizontal and vertical units, and worm and gear sets for equipment builders' use.

180 COPPER AND COPPER ALLOY SPECIFICATIONS INDEX

American Brass Co.—The first edition of this Index, published 2 years ago, and the 1949 edition, were extremely well received by thousands of men in the metalworking field. Many more thousands are doubtless unaware of its existence. It is, of course, the only compilation of its kind.

181 HORTON WATERSPHERE

Chicago Bridge & Iron Co.—8-page Leaflet describing the Horton Watersphere built in standard capacities of 25,000 to 250,000-gals. to provide gravity water pressure in municipal water systems or for general service and fire protection at industrial plants. The leaflet entitled "The Watersphere" contains photographs of 6 Waterspheres of various sizes.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you by number . . . fill in coupon on page 42 and mail promptly.

182 ADJUSTABLE FLOW REGULATORS

Waterman Engineering Co.—Announces the development of an adjustable flow regulator for cylinder speed control. This adjustable regulator gives a constant rate of flow regardless of pressure fluctuations or change in work resistance at any setting within the adjustable range. Adjustable range is 50% of the calibrated flow rate in GPM. It is available for hydraulic systems with operating pressures to 3000 psi. Line sizes are $^1/_4$", $^3/_8$", $^1/_2$" and $^3/_4$" NPT (dry seal). Maximum controlled flow is 16 GPM.

183 RECORDING MECHANICAL COUNTERS

Streeter-Amet Co.—New illustrated Bulletin on latest recording mechanical counters actuated by electrical impulses. Many new uses for these recording counters are depicted for industry as well as for science. Machine shops, airports, hospital, scientific laboratories are among the wide range of fields where they can be used with profit. Variable components multiply the recording possibilities for a variety of counting and timing jobs.

184 FLEXIBLE METAL HOSE

Atlantic Metal Hose Co.—Catalog No. 500 entitled "Atlantic Flexible Metal Hose" contains full description of interlocking hose for high pressure, diesel exhaust and conveyor use, seamless hose for high pressure and diesel exhaust applications; gasoline hose both metal lined and synthetic rubber. Test tables and installation methods are included as well as a full description of couplings.

185 CENTRIFUGAL PUMPS

Allen-Sherman-Hoff Co.—Catalog No. 850 illustrates and describes the complete line of Hydroseal slurry, sand, and dredge pumps, and shows how the hydrosealing principle is applied to each type to reduce wear, maintain efficiency, and save power. Engineering data are given in a form that allows rapid circulation of the pump and power required to meet all operating conditions. A simplified chart shows the annual power savings possible with Hydroseals.

186 PIPE-LINE CONVEYORS

Hahn-Pitz Corp.—Catalog No. 18 for ashes, fly ash, siftings, etc. with hand fired, stokered and pulverized coal burning boilers. Economical in steam-consumption and maintenance.

187 FELTS

American Felt Co.—Has available a special S.A.E. Folder containing technical data and specifications of the various felts made to S.A.E. standards. The folder includes illustrative samples.

188 PLATE STEEL FABRICATION

Nazareth Steel Fabricators, Inc.—Folder contains pictures of fabricated jobs and a buyer's reference listing over 300 items used in such industries as Power, Utilities, Cement, Paper, Chemical and Machinery Manufacturers. Exacting dimensions are met for these industries, the U. S. Army, Navy and Maritime Commission, with precision fabrication.

189 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Bulletin 496. New and up-to-date information illustrating assembly features and installation data pertaining to continuous ash discharge and power dumping spreader stokers. See our advertisement in ASME Mechanical Catalog and Directory, page 17.

190 PROCESS INDUSTRIES EQUIPMENT

General American Transportation Corp.—2-page Catalog describes and illustrates the company's diverse manufacturing and service activities. Tank cars for all manner of liquid commodities. Trans-Flo cars for flour and dry granular products. Wiggins Gasholders and Vapor Seals. Dryers, Filters, Evaporators and Turbo-Mixers: the operating of 4 liquid storage terminals in addition to the leasing of refrigerator and tank cars.

191 WATER TUBE BOILERS

Babcock & Wilcox Co.—Bulletin G-72 describes the Integral-Furnace Boiler Type FM, a completely shop-assembled boiler for unit shipment, available in standard sizes for load ranges from 7000 to 25,000 lb. of steam per hour at pressures up to 250 psi. Details of design, construction, installation, and operation are discussed and illustrated.

192 INDUSTRIAL HEAT PROCESSING

Hauck Manufacturing Co.—Hauck Proportioning Oil Burner—a single lever controls oil and air simultaneously with constant oil-air ratio. Gives accurate firing control for manual or automatic operation.

Continued on Page 64

These men are working for you

C. B. McLAUGHLIN, active, fast-thinking Manager of Tube Turns' Engineering Service Division, checks important design point on new application idea.

Enthusiastic, enterprising G. A. GAUM, Sales Engineer, winds up extensive field trip with information that may save Tube Turns' customers time and money.

D. R. CHEYNEY, alert, ingenious Sales Engineer, visits a Tube Turns' customer with recommendations on alloy fittings designed to whip corrosion problem.

Conscientious, analytical J. D. TOLLIVER, Sales Engineer, goes into the field for performance data that can result in important contribution to piping technology.

IMPORTANT link between Tube Turns, Inc. and its customers is the group of skilled, experienced engineers who staff its Engineering Service Division. Their job: to expand piping technology through studies of piping performance and problems in the field; to enlarge the scope and utility of Tube-Turn welding fittings and flanges.

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193 AUTOMATIC CONTROLS

General Controls Co.—100-page Catalog contains descriptive information and illustrations on complete line of Automatic Pressure, Temperature, Level and Flow Controls for Heating and Air Conditioning, Refrigeration, Aircraft and Industrial and machine specialty applications.

194 ACCELEROMETERS AND PRESSURE PICKUPS

Fredric Flader, Inc.—A 6-page Bulletin describing miniature bonded strain gage instruments for highly accurate measurements in conjunction with radio telemetering or direct recording systems. Folder includes performance characteristics, ranges, dimensions, photographs, and other pertinent data including temperature compensation tolerances of accelerometers, pressure gages, airspeed transmitters, altimeters, and other instruments.

195 DIE-LESS DUPLICATING

O'Neil-Irwin Mfg. Co.—Hydraulic Power Bender, Variable Speed Powershear and Air Powered Rod Parter have all been added to the "Di-Acro" Line to increase the production possibilities of the "Di-Acro" System of Die-Less Duplicating. 40-page "Di-Acro" Catalog contains complete information covering these power machines as well as all manually operated "Di-Acro" Benders, Brakes, Shears, Rod Parters, Notchers and Punches, which are offered in a variety of sizes.

196 ANACONDA COPPER AND COPPER ALLOYS

American Brass Co.—New edition of Anaconda Data Book contains 138 pages of tabulated weights and standard dimensions of copper and brass mill products, as well as compositions, physical constants and properties of copper alloys. Miscellaneous data tables include conversions, comparisons of standard gages, capacities of tanks, dimensions of circles and squares, and mathematical rules and formulae.

197 FACILITIES AND PRODUCTS

Newport News Shipbuilding & Dry Dock Co.—40-page Bulletin containing illustrations and information on the facilities and products other than shipbuilding of the Newport News company. Steel fabrication, subassembly methods, sheet metal facilities, machine shops, forging, and foundries are featured in the publication.

198 MATERIALS HANDLING EQUIPMENT

Clark Equipment Co., Industrial Truck Div.—New Condensed Catalog of materials handling machines and attachments provides basic specifications for all models of Clark fork-lift trucks, industrial towing tractors, Tructractors and special handling attachments. Information includes capacity, dimensions, center of gravity, turning radius, lift heights, etc., for both electric and gas-powered models.

199 OIL-HYDRAULIC PRESSES

Denison Engineering Co.—New 16-page Bulletin 120-A illustrates and describes the versatile, oil-hydraulic Multipress in capacities from 1 to 35 tons. Pictures many on-the-job applications of these presses tooled with cost-cutting accessories. Lists 137 typical examples of work performed on the equipment. Also includes information about Denison pumps, fluid motors, and high pressure valves.

200 FITTINGS AND CARRIERS FOR WALL FIXTURES

J. A. Zurn Mfg. Co.—Catalog No. 50 presents comprehensive data on Fittings and Carriers for supporting Wall Fixtures of all types. Interesting data on new sanitation standards for public and private toilet rooms, including industrial, municipal and all types of construction. Standards accepted by all plumbing fixture manufacturers.

201 POWERED HAND TRUCKS

Clark Equipment Co., Industrial Truck Div.—New powered hand trucks, electric and gas-powered with motors mounted in the drive wheel, are described in a Clark booklet. The gas-powered model employs a hydraulic drive, with engine power transmitted through a variable displacement hydraulic pump to a constant displacement hydraulic motor.

202 CONVEYOR ROLL BEARINGS

Marlin-Rockwell Corp.—M-R-C Conveyor Roll Bearing Bulletin (Form 1529) is a 4-page, 8½" x 11" illustrated folder on M-R-C CONV-3-SF and CONV-4-SF ball bearings. These bearings are specially designed for use on conveyor rolls, and have four important features, resulting in reduced machining operations, cheaper mounting costs, reduced belting cost and improved belt alignment.

203 ROLL GRINDERS

Farrel-Birmingham Co.—New Bulletin (No. 118), contains complete information about Farrel two-wheel, swing-rest roll grinders, which will be of interest and practical value to engineers and operating men responsible for roll maintenance in the

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you. *Distribution by us to students is not included.* The coupon on page 42 should be mailed on or before December 15 in U. S., December 24 elsewhere.

paper industry. This 16-page booklet fully describes and illustrates the swing-rest principle, which contributes importantly to the machine's extreme accuracy when grinding long rolls. Also included are tables giving specifications, dimensions and weights, a typical foundation plan, and illustrations and brief descriptions of a Yankee dryer grinder and a rubber roll grinder.

204 STEAM TURBINES

Murray Iron Works Co.—Bulletin T-122 illustrating and describing Murray Type UV steam turbines. Type UV turbines are designed for modern steam pressures and temperatures. UV turbines may be provided with features and accessories for any type of drive.

205 POWER TOOLS

Mall Tool Co—A line of portable-power tools is described in Bulletin No. 509 which consists largely of photographs of the various power tools which comprise the Mall line. Accompanying each photograph is text which lists the tools' specifications and describes the job it is intended to do. The text also covers the various accessories designed to increase the usefulness of Mall tools. Items listed in the catalog include the MallSaws, the MallSaw stand, MallDrills, attachments for use with the drills, MallSanders, portable polishers, flexible shaft grinding and sanding machines, carpenters' planes, and others.

206 PUMPS

American-Marsh Pumps, Inc.—Boiler Feed and General Service Pump Bulletin No. 381. Describes and pictures this ball bearing, horizontally-split case, two-stage, single-suction centrifugal pumping unit. Shows electric motor and steam turbine driven models, 12 important features in large cross-section, specifications, general dimensions, metal specifications and modifications.

207 DUST COLLECTORS

Northern Blower Co.—Automatic Bag Type Dust Collectors for heavy duty continuous service are described fully in Bulletin 164-2. This equipment is designed for constant volume of air handled and constant static loss. Norblo dust collector operates at constant efficiency and capacity. The cleaning style can be varied for different dust loading in a few minutes without shutting down. Any compartment can be cut out of action for repair or maintenance and all other compartments will continue in operation indefinitely. Norblo collectors, including fans, are completely fabricated by them.

208 STEAM GENERATORS

Superior Combustion Industries, Inc.—Superior Steam Generators are the subject of an 8-page, colorfully illustrated Catalog. In addition to listing complete specifications of 17 sizes ranging in capacity from 20 to 500 h.p. for pressures up to 250 p.s.i. the catalog is replete with technical data combined with illustrations explaining features and detail of construction.

209 SEPARATORS AND EXHAUST HEADS

Wright-Austin Co.—Separator and Exhaust Head Catalog No. 500—24 pages. Extensive descriptions and sectional illustrations of Live and Exhaust Steam, Air and Gas, and Receiver-Type Separators and Exhaust Heads for removal of moisture, water and oil. Applications, dimensions, weights, and engineering data also are given.

210 GENERAL PURPOSE FANS

New York Blower Co.—Portable self-contained units of medium capacity for ventilating and industrial applications. New 8-page Bulletin, No. 401, describes these fans, furnished in three types and eight basic sizes with capacities from 400 c.f.m. to 18,000 c.f.m., together with dimensions and engineering data.

211 FLEXIBLE COUPLINGS, UNIVERSAL JOINTS AND VARIABLE SPEED PULLEYS

Lovejoy Flexible Coupling Co.—Complete Catalog of—"Lovejoy Flexible Couplings," many hundreds of thousands of them giving satisfactory service on everything from oil burners to excavators—"Lovejoy-Dix Universal Joints," precision built from finest alloy steels combined with extremely careful design, will operate at a much greater angle than the normal joint—"Lovejoy Ideal Variable Speed Pulleys, Bases, Sheaves, Belts and Transmissions." Fully described and illustrated. Contains engineering data and charts.

212 FLOW METERS

Hays Corp.—A new type of flow meter which features a magnetic clutch to transmit the movement of the float instead of the conventional mechanical arrangements. The new meter is called the Hays-Penn Magna-Clutch. The magnetic clutch prin-

Continued on Page 66

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ciple is not entirely new. Magnetic clutch flow meters have long been in use in Europe, but their development in this country was hampered by the unavailability of high powered magnets and non-magnetic metal wall material of sufficiently high tensile strength, both of which are now obtainable. A full description of the new meters with dimensions and specifications is given in Bulletin 49-915.

213 MULTI-USE AIR MOTORS

Gardner-Denver Co.—Handy information on how to utilize the unique advantages of compressed air power is available to design engineers in a 12-page Bulletin AM-1. This bulletin describes the complete line of Gardner-Denver five-cylinder radial air motors—in five sizes ranging from 3 to 15 horsepower—in reversible or non-reversible models for direct drive, or with built-in gear reduction. Gardner-Denver Multi-Use Air Motors offer the safety and flexibility of air power, together with simplicity of control and freedom from damage due to overloading. The bulletin also contains specifications on the Gardner-Denver packaged engine starting unit, with automatic air actuated pinion engagement.

214 CONVEYORS AND MATERIALS HANDLING EQUIPMENT

Mechanical Handling Systems, Inc.—Illustrated Bulletins including engineering data covering materials handling problems. Bulletin M-3, "Monoveyors," contains complete information on overhead trolley conveyors. F-5, Floor Type Conveyors. L-1, "Eleveyors," portable and adjustable inclined belt conveyors. TV-1, "TwinVeyors," flexible and portable conveyor for bagged goods. RV-1, "Rope Veyor," flexible and portable conveyor for bags, cartons, cases, packages, etc. R-2, "Universal Work Carriers," tiering racks for transportation and storage of miscellaneous products. C-1, "Collapsi Bin," combination heavy duty bin, rack, and pallet in one unit.

215 AIR COOLED ENGINES

Briggs & Stratton Corp.—Folder printed in two colors showing complete line of current single cylinder, 4-cycle, air cooled engines. Includes dimensional specifications and horsepower data.

216 HYDRO-SHEAVE DRIVE

Twin Disc Clutch Co.—4-page Folder describes new Hydro-Sheave Drive, designed for use with Worthington QD Sheaves on small gasoline engines and electric motors in the ¾ to 25 hp range. Hydro-Sheave Drive, a hydraulic power transmission incorporating the Twin Disc Small Hydraulic Coupling, permits unit to be selected on basis of running load . . . provides smoother operation . . . prevents stalling.

217 INSTRUMENTS

United States Gauge, Div. of American Machine & Metals, Inc.—72-page Catalog containing full information on pressure, temperature, flow, level and electrical measuring instruments . . . "the most complete line of its kind in the world." Details and illustrations of production and test methods show why "6 out of 10 original equipment manufacturers specify USG." Photographs, tables and diagrams supplement full gauge descriptions and recommended applications.

218 DUST COLLECTORS

Prat-Daniel Corp.—Prat-Daniel Tubular Dust Collectors—Valmont Type "S" and Standard Type H.C. This Bulletin describes new developments in tube design that increase efficiency through improvement of the size and shape of the inlet aperture so as to admit incoming gases in the shape of a deep, narrow ribbon. This reduces the distance the dust particles travel before coming in contact with the precipitating wall, and results in great collection efficiency. Bulletin also contains details for using mechanical collectors in series with electrostatic. Bulletin No. 250-S.

219 A MODERN FORGE SHOP

Kropp Forge Co.—Vol. 10, No. 3, issue of Forgings describes the growth of America's largest job forge plant and gives a pictorial trip through each department of the company . . . explaining how Kropp forged parts have rendered valuable service to the automotive, aviation, machine tool, petroleum, construction and other industries.

220 FLEXIBLE COUPLINGS

Lovejoy Flexible Coupling Co.—Illustrated Catalog with Selector Charts. Grouping and application of L-R Flexible Couplings. Describes and pictures various types of couplings, with cutaway views and diagrams. New couplings for D-C standard mill motors. Selector Charts make it easy to choose correct type and size of coupling with proper cushion material for application.

221 PRESSURE REGULATORS

Davis Regulator Co.—Bulletin No. A-50 describes the standard Davis line of pressure regulators and reducing valves for steam, air, gas, water, oil and other fluids. Complete data on 18 standard types in sizes up to 24" and for pressures to 1500 p.s.i.

222 CENTRIFUGAL PUMPS

Dean Brothers Pumps, Inc.—New 28-page Catalog describing complete line of Centrifugal Pumps for Industrial, Chemical, Petroleum and General Service. Photographs, Sections, Selection Tables, Parts Lists, Dimension Sketches and Material Specifications serve to illustrate the large degree of interchangeability and adaptability that has been achieved in the design of these pumps.

223 FLEXIBLE BALL JOINTS

Barco Mfg. Co.—For piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalis, and other fluids or gases. Suitable for pressures up to 750 psi, steam, and 6,000 psi hydraulic. Sizes ¼" to 6". Catalog 211.

224 AUTOMATIC BLOWDOWN SYSTEMS

Henszey Co.—New Catalog, describing the Henszey Continuous Automatic Blowdown System explaining in detail the necessity for blowdown. This catalog lists the various types of blowdown installations available for every size of boiler plant. Drawings of recommended blowdown systems are included, and comments and recommendations regarding best blowdown procedures are included.

225 CHAIN GRATE STOKERS

Illinois Stoker Co.—Catalog describes a Chain Grate Stoker with medium height side frames for installation under boilers up to about 500 horsepower. The side frames are of ample height to admit sufficient air required for combustion and this construction saves at least one foot in the setting height of the boiler. The stoker is used for either free burning bituminous coal or anthracite.

226 PULVERIZERS

Strong-Scott Mfg. Co.—28-page Brochure describes theory of design of unit pulverizers, details of construction, typical engineering layouts, and many illustrations of typical applications to boilers, kilns and driers. Emphasis is placed upon flexibility, and adaptability to unusual local conditions, especially in existing boiler rooms, and where atmospheric pollution (fly ash) is taboo.

The Latest Industrial Literature

offered in this list represents recently issued Catalogs, Bulletins, Handbooks, Data, Booklets, Charts, Informative Folders and other engineering information made available by current advertisers in ASME Publications.

227 AUTOMATIC VALVES AND CONTROLS

A. W. Cash Co.—Bulletin No. 330, reviews in the briefest possible manner the more commonly used valves, regulators and controls for pressure regulating, volume flow, and liquid level. The illustrations and descriptions shown in the bulletin, brief as they are, will show the broad scope of automatic control, and suggest the possibilities which proper application of these devices can serve.

228 DEEP DRAWN SHAPES AND SHELLS

Pressed Steel Tank Co.—General Catalog and Bulletins describing cylinders for propane, butane, anhydrous ammonia, chlorine, refrigerant gases and numerous other gases. Also illustrates barrels, drums, containers, air receivers and special packages. Text covers data on capacities, pressures, codes and materials.

229 ROTARY SWIVEL JOINTS

Barco Mfg. Co.—Catalog No. 262 describes the new Rotary Swivel Joint for use on swivel and slow rotating applications up to 30 RPM. It has very low turning torque even at extreme temperature and pressure ranges. Provision for angular flexibilitd eliminates side strain. It is compact, light in weight and is low in cost. Standard models handle 300# working steam pressure, extra heavy models 600# steam and 2500# hydraulic. 3/4" to 2" pipe sizes.

230 STEEL AND ALLOY PLATE FABRICATION

Nooter Co.—New 16 page Folder indicating descriptive applications in stainless steel, copper, nickel, aluminum and various alloys, together with comprehensive corrosion data charts, indicating the use of each of these materials, fabrication of processing equipment built around the use of shielded arc, atomic hydrogen, oxyacetylene and automatic submerged head types of welding.

231 STEAM GENERATORS

Hapman-Dutton Co.—One of the most informative pieces of literature on the subject of Self-contained Packaged Type Steam Generators is new Bulletin No. EC-74 which gives the "inside" story of the Econotherm, oil and gas fired steam generator.

232 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—Just released, new 16-page Helicoid Gage Catalog. The Helicoid Gage is the only pressure gage with the Helicoid Movement. It is guaranteed accurate to within 1/2 of 1% of the total dial graduation over the upper 95% of the 280° dial arc. This means that on a 100 lb. dial, for example, accuracy is guaranteed to within 1/2 lb. over the entire scale except from 0 to 5 lbs. A newly designed adjusting mechanism, located in the rear of the gage, makes possible recalibration without removing the pointer and the dial. This is a feature industry has long been looking for. Cutaway photographs and line drawings show the complete line of Helicoid Gages, how they work, what goes into them, how they're put together, and the reason why they're so accurate.

233 SPEED REDUCERS

Cone-Drive Gears, Div. of Michigan Tool Co.—Condensed Catalog, Bulletin 8901-50, of standard double-enveloping gear speed reducers, covering some 190,000 combinations of sizes, ratios and types (all available from stock) into a single 8-page bulletin designed so that it can be used either as a self-mailer or as a salesmen's literature. An accordion fold puts all information relating to each size range of reducers on adjacent pages for quick reference. The bulletin contains complete information on ratings of all sizes and types, dimensional drawings and specifications, features, how-to-order, information, etc.

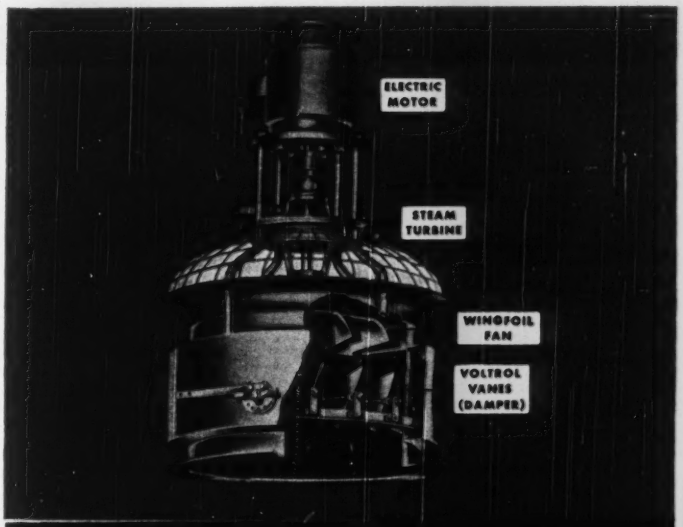
234 STOKERS

Westinghouse Electric Corp.—Medium capacity Stokers (up to 40,000-50,000 lbs. of steam per hr.) are described in two recent books: Booklet B-2196-A, "Westinghouse Single-Retort Link-Grate Stokers" describes savings in steam cost possible through Underfeed Stoker firing, utilizing the unique Westinghouse Link-Grate principle of undulating grate motion. Booklet B-3890-A, "Westinghouse Centrafire, with the famous Link-Grate," presents the unique Centrafire principle of firing which distinguishes this unit from the ordinary type of Spreader Stoker. Low velocity monoxide gases with low particle-carrying capacity rise above the central fire zone where monoxides are converted to CO_2 by admixture with metered overfire air. Construction, operation, automatic synchronous operation from single-source hydraulic drive, and application to various boiler types, are also discussed.

235 MONORAIL TRACTOR

Detroit Hoist & Machine Co.—Bulletin No. 810 illustrates and describes a new idea in traction effectiveness which has been included in the New Trojan, Electric Motor Traveled, Monorail Tractor for

Continued on Page 68



New Wing Forced Draft Blower Incorporates both turbine and electric drive in one unit

With the new Wing Dual Drive Forced Draft Blower you can alternate between turbine and electric drive. Your choice of drive may be governed by consideration of heat balance, of economical operating cost, or by an emergency affecting the source of power. All you have to do is throw a switch to operate the motor or turn a couple of valves to change to turbine drive! There is no harm to either motor or turbine when one or the other is idle. A wide range of control is possible in both motor or turbine drive. Throttling gives adequate control with turbine drive and the Wing Voltrol Vanes (capacity regulating dampers) permit capacity regulation when constant speed motor is driving. Automatic operation may be arranged with combustion-control system. The unit is extremely compact and may be adapted to either vertical or horizontal discharge. Installation is simple, easy and economical. It is shipped completely assembled and aligned, ready to bolt to the foundation.

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Canadian Factory: Montreal, Canada

WING

Wing DUAL-DRIVE BLOWERS

traveling various materials handling and other types of units on monorails tracks or rails by electric power. Many material handling and various other types of units at present hand operated and difficult to move can be power-traveled faster and economically by this tractor.

236 V-BELT DRIVES

Medart Co.—Bulletin VE-48. A complete new bulletin on the engineering of V-belt drives, containing the new Medart type SL V-belt sheave. Complete engineering tables and drive section tables in condensed and easy to interpret arrangement.

237 HIGH-SPEED MOTION PICTURE CAMERAS

Wollensak Optical Co., Industrial & Technical Div.—Catalog contains information, specifications and applications of the 8-, 16-, and 35-mm Fastax High-Speed Motion Picture Cameras. These cameras make motion studies of mechanical, electrical, physical and anatomical reflexes and vibrations . . . permit the taking of pictures up to 14,000 frames a second.

238 HYDRAULIC "OIL" POWER EQUIPMENT

Vickers, Inc.—Bulletin No. 5000 contains general design information and specifications of a complete line of pumps, valves, controls and related equipment for oil hydraulic power transmission in machine-tool and general industrial field. Individual units, also standardized or custom-built power units, transmissions and control panels available.

239 GAS AND OIL BURNERS

Todd Shipyards Corp., Combustion Equipment Div.—New illustrated Booklet describes the Todd "AG" and "AGLO" Burners, automatic package units, gas or combination gas-oil burners for medium size requirements. Text matter contains complete information about application, advantages and operation, with full data on gas and oil firing capacities.

240 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1951 Catalog of ASME Publications. A 20-page descriptive price list of current books, standards codes, research reports, and periodicals published by the Society.

241 FLEXIBLE COUPLINGS

American Flexible Coupling Co.—New 12-page two-color Catalog No. 501 includes comprehensive information and technical data on Amerigear gear type flexible couplings designed with unique curvature on flanks of gear teeth. Also full information on new Series "D" American Oldham type flexible couplings. The choice of two proven types of flexible couplings made by a manufacturer specializing in flexible couplings only enables greater engineering choice to be made.

242 CONVECTORS

John J. Nesbitt, Inc.—12-page Catalog (Publication No. 262) describes Model U Convector, construction features. Dimensions and capacities for standard and special purpose sizes. Steam capacities at 1-lb. pressure and above. Forced hot water capacities by direct reading and the B.t.u. method. Water quantities in gallons per minute and resistance to water flow.

243 WATER CONDITIONING

Permutit Co.—Hot Process Softener Booklet No. 2341A describes Hot Lime Soda Softeners of the new sludge blanket design, filters, accessories and testing equipment. The two-stage Hot Zeolite Softener which eliminates second-stage phosphate treatment is illustrated and described as well as Permutit's new Electro-Chemical Solution Feeder with remote control indicator.

The "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 243 items to make selections from. For convenience an index may be found on pages 41 and 42. Select desired catalogs by number, fill in coupon on page 42 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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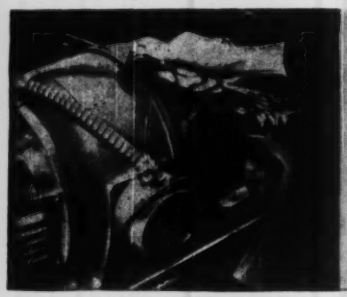

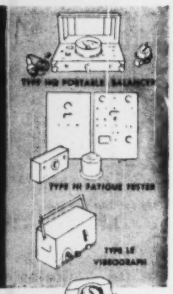

TYPE MH VIBROMETER

Measure Vibration *in a hurry!*

Track costly vibrations with inexpensive tools. The Westinghouse Types MH and JC-1 Portable Vibrometers are instruments that supply immediate readings of amplitude and frequency respectively. They provide data essential for elimination of harmful vibration. For complete information on this and other vibration testing equipment, write Westinghouse Electric Corporation, Department E-3, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-02211

Westinghouse VIBROMETERS

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• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

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Imperial Pencil Tracing Cloth is right for ink drawings as well.

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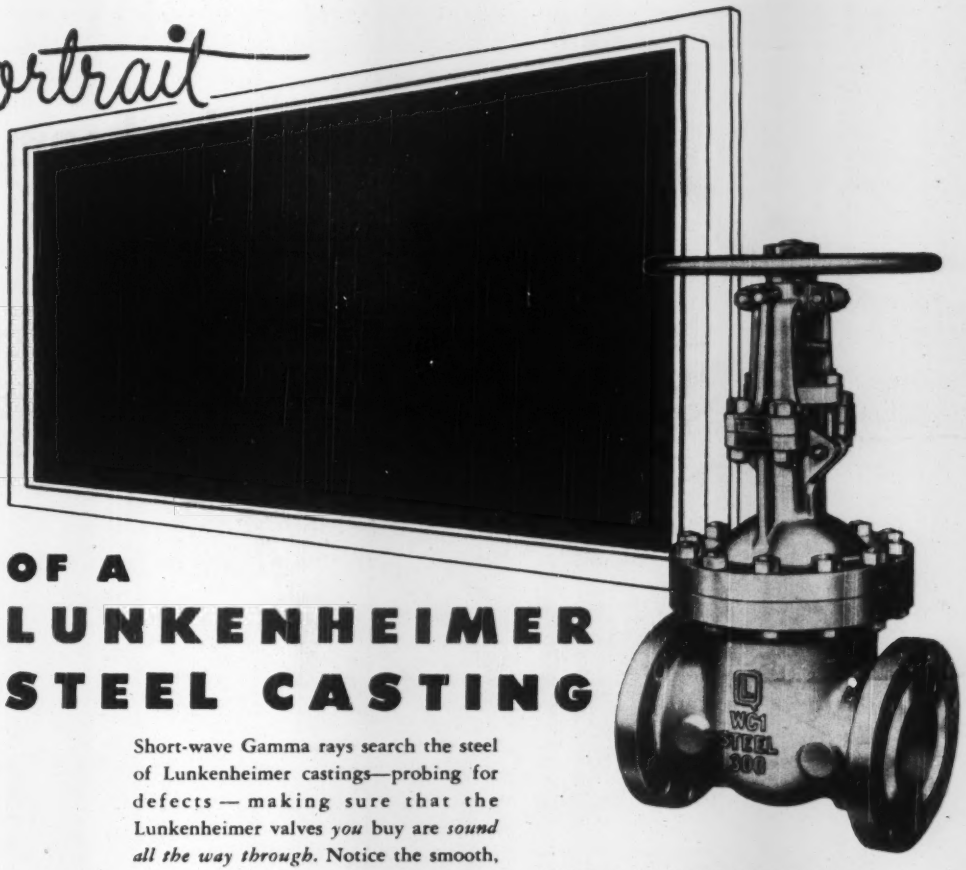

OF A LUNKENHEIMER STEEL CASTING

Short-wave Gamma rays search the steel of Lunkenheimer castings—probing for defects — making sure that the Lunkenheimer valves *you* buy are *sound all the way through.* Notice the smooth, even structure shown in this radiographic film. It is an x-ray portrait of steel valve strength, free from the telltale localized shadows that mark internal danger spots.

Radiography is only one of the many test-procedures that insure *high quality* for Lunkenheimer steel valves. All pressure-parts for large steel valves are given a Magnaflux test in addition to their regular visual inspection. And every steel valve is tested far in excess of rated pressures.

When you buy Lunkenheimer steel valves, you get *more* than mere pressure-tightness. Lunkenheimer engineers are not satisfied with meeting minimum specifications; they are interested in attaining the soundest possible metal structure in every section. That's why Lunkenheimer valves last — and last.

For detailed information on the metals and trim that will best serve *your* valve requirements, get in touch with your nearest Lunkenheimer representative. Or write The Lunkenheimer Company, Box 360E, Cincinnati 14, Ohio.

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WE'LL LOOK FOR YOU AT THE NEW YORK POWER SHOW - BOOTH 52

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THE ONE *Great* NAME IN VALVES

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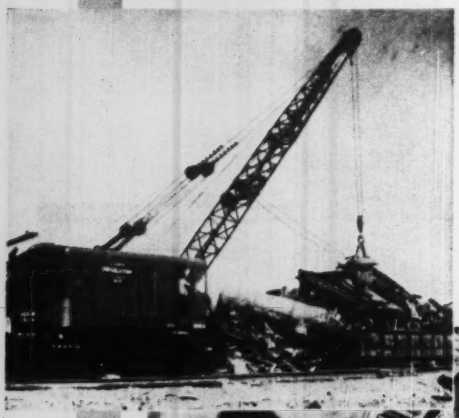
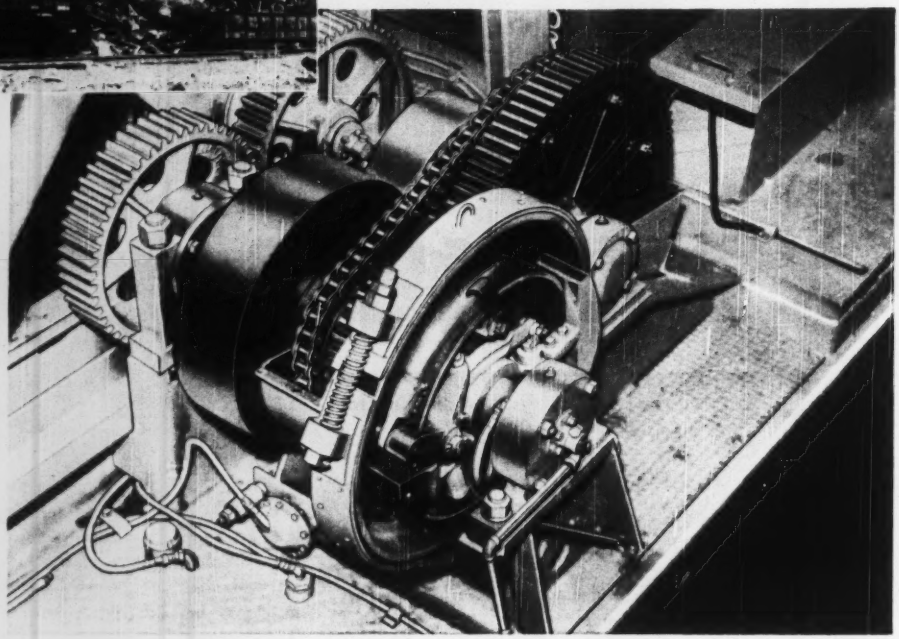
lowering the boom with the help of . . . .



American Hoist & Derrick Company's great new DiesElectric Locomotive Crane. At the touch of a button, magnet gets an instantaneous extra shot of power, lifts and holds with the same force as though magnet size were increased by 20%.

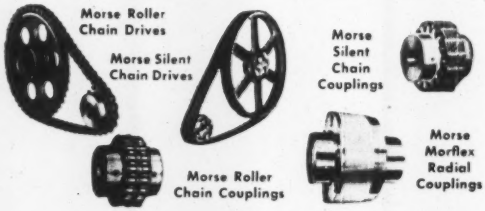


Morse Roller Chain Drive featured in patented boom hoist on American Locomotive Crane. Drive controls lowering speed of boom, which may carry as many as forty tons. There is no room for slip-up or parts failure.

Ask the Morse Man for power transmission information!

100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.


Morse Roller Chain Drives
Morse Silent Chain Drives
Morse Roller Chain Couplings
Morse Silent Chain Couplings
Morse Morflex Radial Couplings

MORSE ROLLER CHAIN DRIVE

The American Locomotive Crane operator pushes a button. The giant magnet picks up its great load of scrap. The crane swings to the freight car, the boom is lowered, and the load of steel is settled in the car as gently as a load of scrap can be settled. There's the picture, and Morse is right at home in it.

In the patented boom hoist, pictured at the left, a Morse Roller Chain Drive plays an important part. This Morse Drive connects the lowering load created by the boom to the engine frictional torque, thereby controlling the boom's lowering speed whether the crane is hoisting, swinging, or traveling.

Why designers and manufacturers prefer Morse

Morse Roller Chains and Sprockets are precision-built, high-quality products that give their best under the worst of working conditions. They are produced for stamina and long life. They resist the effects of poor lubrication and rugged working conditions. Morse Roller Chain Drives use teeth, not tension, are positive, can't slip. They are 99% efficient.

In almost every field of design and manufacture, engineers have found that Morse is the answer to power transmission problems. And whether you need roller or silent chain drives, clutches or couplings, in standard or special applications, your results will be right, too, if you apply the formula M = PT.

M=PT
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Morse *means*
Power
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Morse Morflex Couplings

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A guide to modern on-the-job management techniques

SMALL PLANT MANAGEMENT

This is a new ASME publication, developed to meet the need of owners and managers of small plants for techniques which can be successfully applied in their plants.

Here twenty authors, each an authority in his respective field, analyze the many functions that aid in the establishment of efficient and profitable management . . . . . from the concepts and principles of scientific management to considerations in financial planning . . . . . from the legal side of production planning to sales tools and their use . . . . . from building employee morale to the know-how rules of machine planning.

To produce this unique guide, the ASME Management Division first determined, with the assistance of practical men familiar with small plants, the specific thinking and action that would give best operation, progress and success in small plants and similar establishments. Outlines of topics to be covered were then prepared and chairmen and secretaries of 64 ASME sections, as well as leading trade associations, professional societies, and government bureaus were called upon to help find qualified authors.

The result is this complete and integrated treatise on small plant management providing expert information on engineering subjects, discussing the know-how in detail and the fundamental procedures which might be used, explaining how know-how can be applied in actual work, and appraising the outlook for small plants in the United States and elsewhere.

CONTENTS

PART I SMALL PLANTS AS ECONOMIC FACTORS

The Economic and Industrial Importance of Small Plants
By Dr. A. D. H. Kaplan, Economist, The Brookings Institution, Washington, D. C.

Small Plant Financing and Banking
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By J. Colbert, Director, Bureau of Community Development, University of Wisconsin, Madison, Wisconsin

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By Charles F. Hughitt, Chief, Small Business Division, U. S. Department of Commerce, Washington, D. C.

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Organizing the Small Plant
By James D. Mooney, Chairman, Technical Managers, Inc., New York, N. Y.

Operating the Small Plant
By Adolph Ehlrecht, Vice President, Gries Reproducer Corp., New York, N. Y.

Supervising and Controlling the Small Plant
By T. Alfred Marshall, Jr., Management Research, Metropolitan Life Insurance Company, N. Y.

PART III HOW TO SOLVE THE IMPORTANT PROBLEMS OF SMALL PLANT MANAGEMENT

How to Fulfill the Legal Requirements
By J. Raymond Tiffany, Attorney, General Counsel, National Small Business Men's Association, New York, N. Y., and Dr. Benjamin Werne, Adjunct Professor, Industrial Relations New York University, Graduate School of Business Administration, N. Y.

How to Get Best Workers and Labor Relations
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How to Get Along with the Union
By Dr. William Gomberg, Director of Management Engineering, International Ladies Garment Workers Union, New York, N. Y.

How to Get Best Facilities and Material
By Henry T. Coates, President, Henry T. Coates & Associates, Clinton, New Jersey

How to Obtain Best Productivity
By Parker Capps, President, The C. I. Capps Company, Inc., Jacksonville, Florida

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By F. W. Miller, Vice President, Yarnall Waring Company, Philadelphia, Pennsylvania

How to Get Best Sales
By Alfred B. De Passe, Sales Consultant, Industrial Bureau, Worcester Chamber of Commerce, Worcester, Massachusetts

How to Do and Use Accounting
By Clinton W. Bennett, Partner, Cooley & Marvin, Boston, Massachusetts

How to Pay and Save in Taxes
By James B. Murray, Vice President, Murray Manufacturing Corp., Brooklyn, N. Y.

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The General Outlook for Small Plants in the United States
By R. Harland Shaw, Assistant to Chairman, Conference of American Small Business Organizations, Chicago, Ill.

Small Plant Opportunities in Latin America
By Joseph J. Maguru, U. S. Department of Commerce, Office of International Trade, Washington, D. C.

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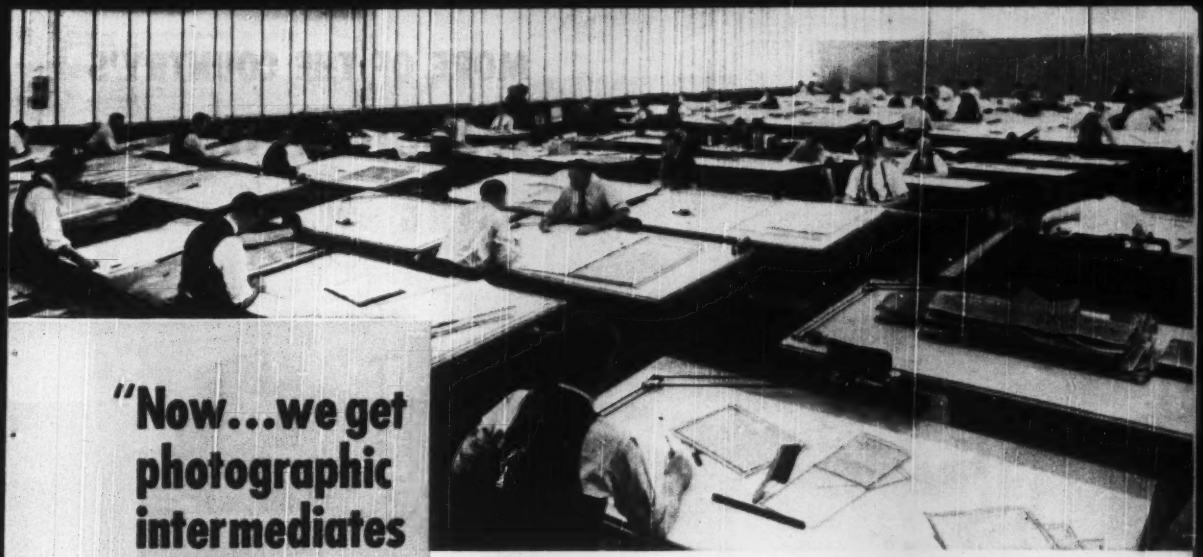

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reports

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Since 1947 the production of photographic intermediates has been easier, faster, more economical for The Heald Machine Co. *Thanks to Kodagraph Autopositive Paper.*

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16

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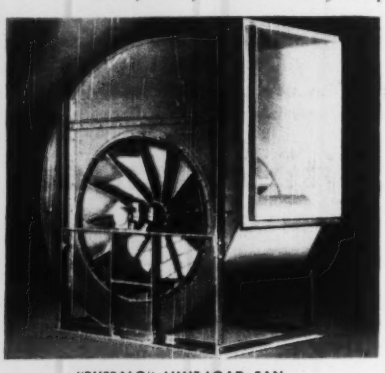
"Buffalo" FANS HELP MAKE CHESTERFIELD CIGARETTES

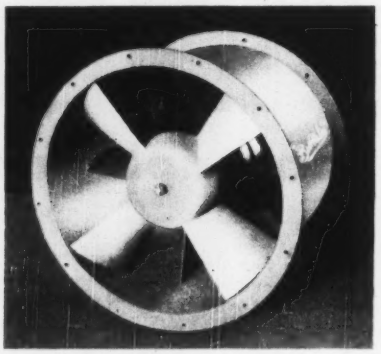
"DEDICATED to the millions who smoke the Cigarette That Satisfies", this new Cigarette Factory and Research Laboratory of Liggett & Myers Tobacco Company, Durham, N.C., are the two most modern buildings in the business.

Important to the high degree of efficiency in both these buildings is perfect control of air conditions. And "Buffalo" Fans supply the dependable "air power". Here is another of the country's leading firms whose building expansion plans have included "Buffalo" Fans. And small wonder — their seventy-two-year reputation for efficiency, easy maintenance and long life is known to engineers throughout the industry.

Specify "Buffalo" for your next air handling job — and you can be sure of the results you hoped for! Write now for information on your particular air problem, and the units to handle it.



"BUFFALO" LIMIT-LOAD FAN



"BUFFALO" AXIAL FLOW FAN

Buffalo "LL" and Axial Flow Fans meet all requirements for quiet, dependable work in both air conditioning and straight ventilation installations.

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Canadian Blower & Forge Co., Ltd., Kitchener, Ont., Branch Offices in all Principal Cities

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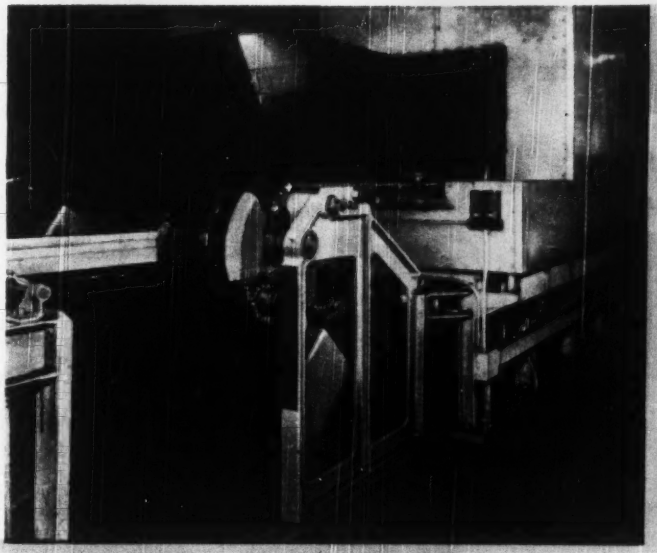
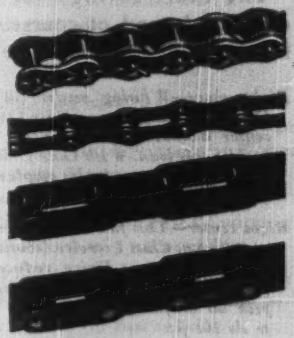


Lithographed metal sheets travel 13 feet per minute through 80 foot oven on twin strands of Link-Belt Precision Steel Roller Chain. High temperature conditions require accurate timing, which is assured by the constant-speed, positive travel, provided by Link-Belt precision made Chain and Sprockets.

neither heat, cold nor moisture can stall LINK-BELT driven RPM

There is a positive, unvarying relationship between the teeth of a Link-Belt Sprocket Wheel and Link-Belt Precision Steel Roller Chain. Neither moisture nor temperature conditions can cause it to slip or lose ratio. For corrosive conditions, chains and sprockets are made of bronze and stainless steel.

May we suggest that you discuss your drive and conveying problems with a Link-Belt engineer. His broad experience in the application of roller chain and sprockets may help you.



Typical Link-Belt Precision Steel Roller Chains for Conveying and Power Transmission.

Link-Belt cut-tooth Sprockets, accurately made to fit chain, assure longest chain and sprocket life.

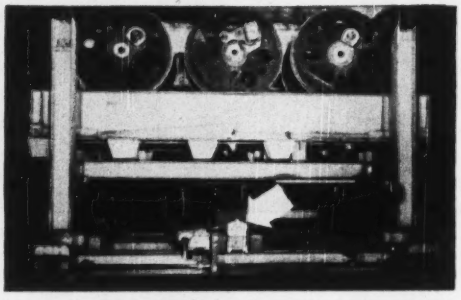
LINK-BELT
PRECISION STEEL
ROLLER CHAINS
AND SPROCKETS

THE SYMBOL OF QUALITY — LB — LINK-BELT

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

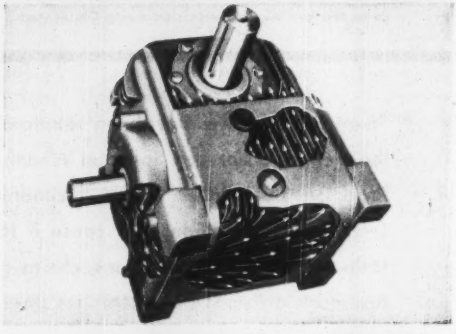
Rx – to reduce { GEAR SIZE GEAR WEIGHT GEAR COSTS



Cone-Drive Gears and speed reducers offer a remarkably simple and effective reducing formula for cutting the size, weight and cost of power transmitting drives.

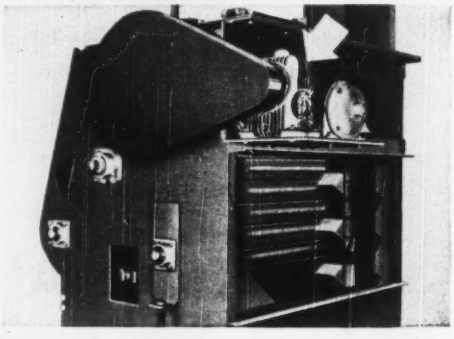
The ingredient that does the trick is "double-enveloping gearing"—the exclusive Cone-Drive construction that gives you more contact per tooth, more teeth in contact and greater load carrying capacity for any given size.

The exact savings—in inches, lbs. and dollars—depend of course on the individual installation. Here are three typical examples:



Right above—Whiting model BW four-screw two-motor Drop Table; hoisting capacity 125 tons. Normally 10-inch center distance speed reducers would be required to handle this load. With Cone-Drive, Whiting gets all the load capacity it needs plus ample reserve using only 6 inch center distance units.

Right center—This fan-cooled Cone-Drive handles 5½ hp at 870 rpm, Class I service (continuous load). Comparing it with non-Cone-Drive reducers for the same load reveals a saving of $95 to $257, depending on whether you pick an 8" fan-cooled or a 10" non-fan-cooled reducer to do the job.



Right below—The manufacturers of automatic tumbling and cleaning equipment for castings and forgings are quite frank as to why they use Cone-Drive Gears to operate drives to their mills and loaders. ". . . they conserve space, give us freedom from service troubles and SAVE US MONEY."

CONE-DRIVE GEARS

CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, U.S.A.

stop coupling failures!

FIND OUT HOW *Koppers Engineers Eliminate Needless Downtime* IN YOUR PLANT!

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . Koppers engineers are acknowledged the best in the industry. Their practical knowledge, backed with 30 years' coupling experience, is at your service!

IMMEDIATE DELIVERY . . . All standard types and sizes are available for immediate delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!

LOWEST COST PER YEAR . . . Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!

KOPPERS

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

Before your plant is harassed by needless coupling failures—*call on Koppers!* Only Koppers offers you a two barreled solution to coupling problems: Fast's Couplings, the original gear-type coupling—and Koppers Engineering Service, acknowledged the finest in the industry!

For *30 years,* Fast's Couplings have been industry's standard for *long life* at *low cost.* Now, in addition, when you specify Fast's you get the *extra* advantage of Koppers valuable Engineering Service. Koppers engineers, backed with 30 years of Fast's Coupling experience, study your problem. Then show *which* Fast's Coupling you need (and more important) *why you need it!*

Only Koppers can offer you both Fast's Couplings and unexcelled engineering service—so before you buy *any coupling,* get the complete story on Fast's. Full details are contained in the Fast's Catalog. For your free copy, send the coupon today!

Send for

FREE CATALOG

KOPPERS CO., INC., *Fast's Coupling Dept.,*
351 Scott St., Baltimore 3, Md.

Please send me a copy of Fast's Catalog relative to.....
.....(type of industry).

Name .....

Company .....

Address .....

City .....Zone.....State.....

Do You Know

WHAT CAUSES BREAKDOWNS... REJECTIONS IN AUTOMATIC MACHINES?

Fastax High-Speed Motion Picture Studies Have Been Made of:

- Machine Shop Tools Working.
- Failure of Rapidly Moving Mechanisms.
- Faulty Design Problems such as shattering relay contacts and cams.
- Gas and Liquid Flow . . . Combustion.
- High-Speed Weaving and Spinning Operations.
- Mechanical, Electrical, Physical and Anatomical Reflexes and Vibrations.
- Other applications too numerous to mention.

WRITE for catalog and information on how Wollensak can equip a high-speed laboratory for you . . . Completely portable and easy to use. Wollensak Optical Co., 801 Hudson Avenue, Rochester 21, N. Y.

Wollensak
MEANS FINE LENSES
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• Distributor in the United States
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Or Your Local Branch
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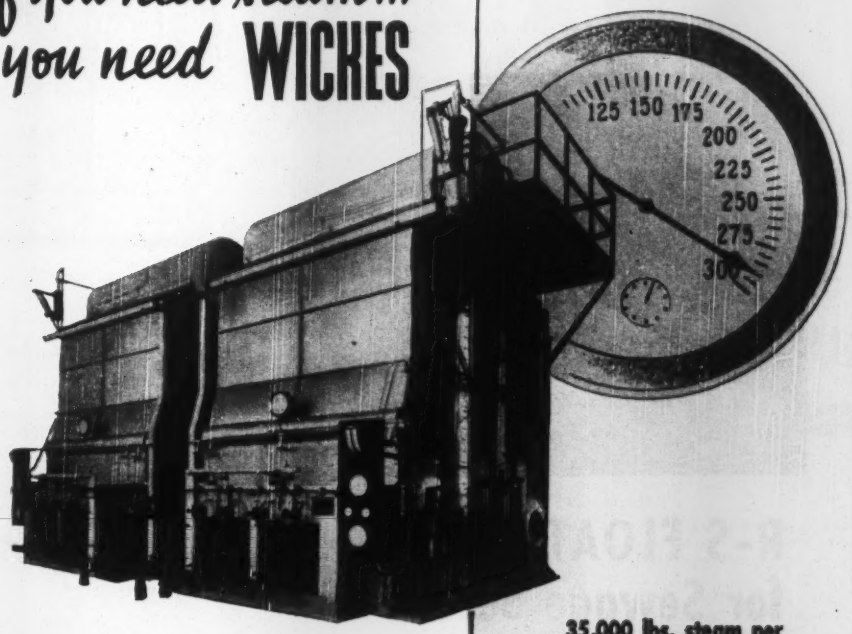
111 Eighth Avenue, New York 11, N. Y., U.S.A.

If you need steam... you need WICKES



35,000 lbs. steam per hour from each of these two WICKES 2-Drum Steam Generators

Throughout the world, industries that depend on steam have learned by experience to depend on *Wickes* Steam Generators. The *Wickes* Type S 2-Drum Boilers shown here have found wide acceptance in the chemical processing industry because the Type S boiler is *adaptable to any standard method of firing* — oil, gas, single retort underfeed or spreader stoker — and, because of the low head design, this boiler is practical where space is limited. *Wickes* can fill your most exacting requirements for steam generators up to 250,000 lbs. steam per hour and 850 pounds per square inch. If you have a boiler problem, our knowledge of steam generation is *available to you without obligation* . . . write today for descriptive literature on *Wickes'* complete line of steam generation equipment.

WICKES

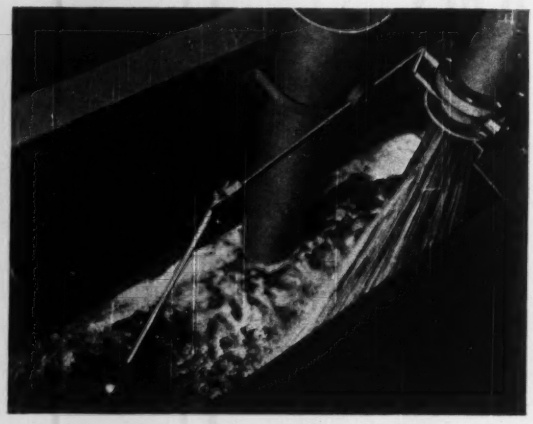
THE WICKES BOILER CO.
SAGINAW, MICHIGAN
DIVISION OF THE WICKES CORPORATION
RECOGNIZED QUALITY SINCE 1854

129

SALES OFFICES: Atlanta • Boston • Chicago • Cincinnati • Denver • Detroit Houston • Indianapolis • Los Angeles • Milwaukee • New York City • Pittsburgh • Saginaw • San Francisco • San Jose • Springfield Seattle • St. Louis • Tulsa • Mexico City • Buenos Aires • Manila • Havana • Montevideo • San Juan, P.R. • Victoria, B.C.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



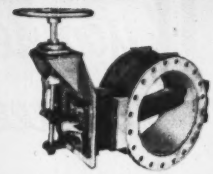
R-S FLOAT VALVE for Sewage Service

The R-S Heavy Duty Direct Action Float Valve controls the water level in a wet well of a sewage treatment plant at Quakertown, Pennsylvania. Illustration shows valve approximately 25% open. At the high level, practically drip tight shut off is obtained with metal-to-metal seat. The adjustable float connection keeps the float away from the area of turbulence.

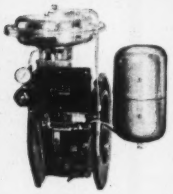
R-S Valves are used in air, gas, liquid, steam and semi-solid service for the shut off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, output control of pumps, fans, engines, turbines and automatic combustion. Suitable for service in the temperature range from minus 300°F to plus 2000°F. 2 to 2500 psig.

Specify R-S Valves for simplified control and shut off. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.



No. 781—Fourteen-inch Heavy Duty Cast Iron Valve with 125-pound American Standard flanges and drilling. Mounting bracket, crank arm, reach rod and linkage together with springless diaphragm top including positioner, gauge and an auxiliary tank as an integral part of the unit. Should all air fail, pressure in the tank will stroke the valve. Note the bronze bushings in bracket through which the air motor shaft passes.

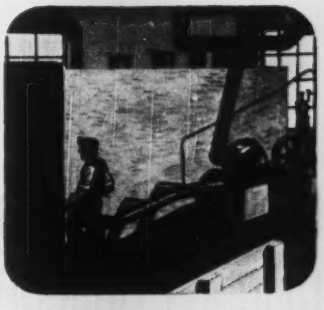
No. 780—Eight-inch Off Center Valve for control of 15 psig saturated steam with 1 psi drop. Series 15, 150 - pound American Standard raised face flanges. Double crank arm with adjustable weights for accurate setting. Cylinder is not an actuator but simply a dash pot. Note 2-inch flanged outlet for overload relief.

No. 782—Heavy Duty Wafer Type Valve, rubber seated, 5° angle seated vane with enclosed gear reduction drive.

Note that there is plenty of room to easily remove the gland and repack the stuffing box.

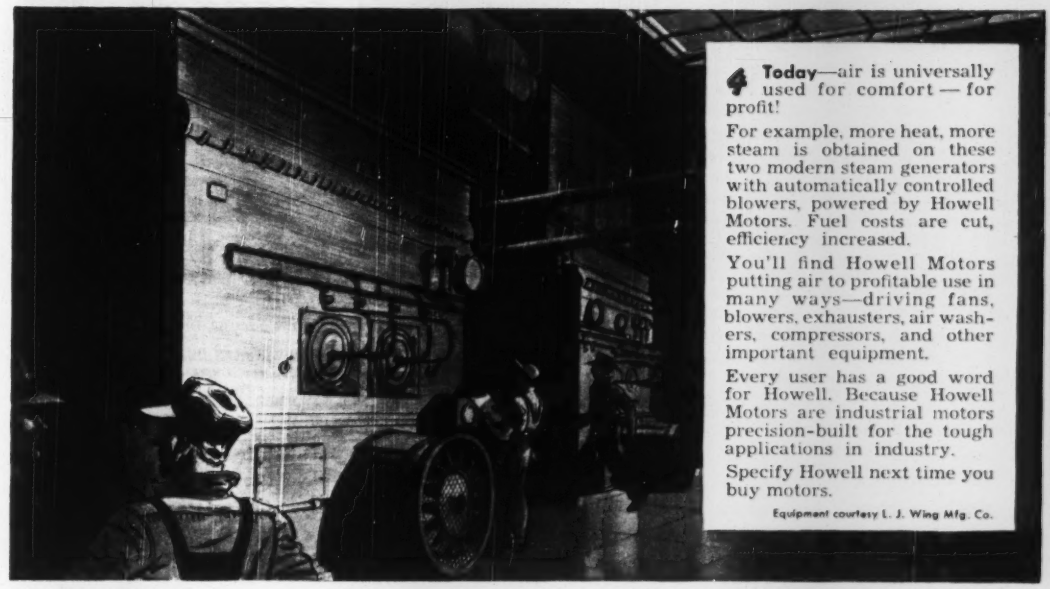
1 **1561**—A crude, manually operated bellows like this was used in an attempt to pump fresh air into a mine in Switzerland. And man's quest for comfort, by putting air to work, was under way.

2 **1700**—This age-old method of moving air for its cooling effect was used in many parts of the world. Needed was a form of low-cost power that would move air mechanically, automatically, and efficiently.



3 **1873**—This steam-operated, forced draft fan promoted efficient burning of fuel in boilers. By 1915, Howell Electric Motors arrived. The era of electrical power put the handling of air on a paying basis.

NOW... AIR IS PUT TO PROFITABLE USE!



4 **Today**—air is universally used for comfort — for profit!

For example, more heat, more steam is obtained on these two modern steam generators with automatically controlled blowers, powered by Howell Motors. Fuel costs are cut, efficiency increased.

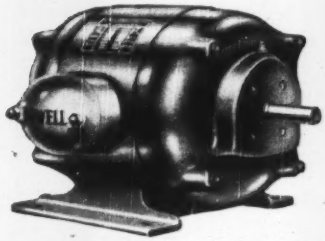
You'll find Howell Motors putting air to profitable use in many ways—driving fans, blowers, exhausters, air washers, compressors, and other important equipment.

Every user has a good word for Howell. Because Howell Motors are industrial motors precision-built for the tough applications in industry.

Specify Howell next time you buy motors.

Equipment courtesy L. J. Wing Mfg. Co.

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.



Howell Protected-Type Motor

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

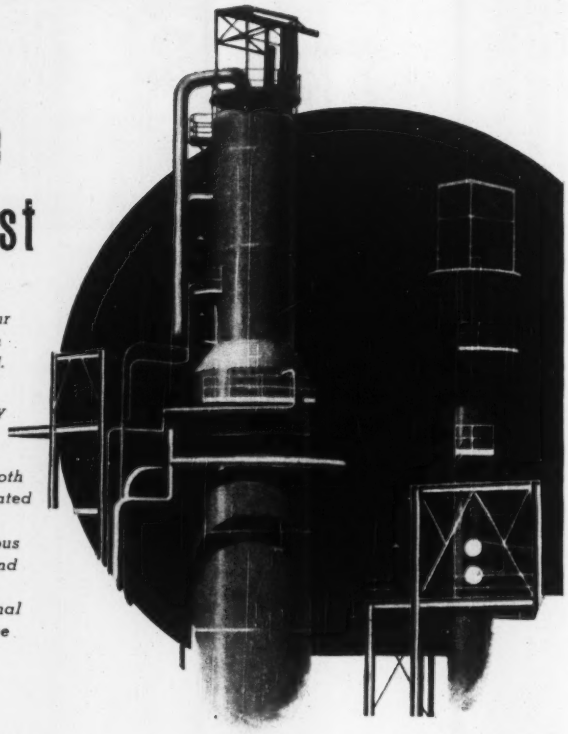
HOWELL Red Band MOTORS

How to Cut Corrosive Crude Processing Cost

PROBLEM: *To minimize cost of distillation of sour crudes and production of lube fractions with minimum decomposition and maximum yield.*

DESIGN: *Combination vacuum unit providing very close processing controls, one of 5 similar units representing the latest improvements in bubble-type refinery equipment design. Both atmospheric tower and vacuum tower fabricated of stainless-clad steel to resist high-temperature corrosion, economically. Judicious spacing of equipment for minimum piping and use of heat exchangers to avoid excess processing heat loss, for maximum operational efficiency. Provision for maximum turbulence without entrainment at bubble-caps, for product quality.*

END RESULT: *Operating economies and high-quality product achieved by equipment with low first cost and long service life, while resisting corrosion from sulfides and organic chlorides in sour crudes.*



In foreground is shown atmospheric tower of distillation unit engineered for construction with Lukens Stainless-Clad Steel by Foster Wheeler Corporation and fabricated and erected in the plant of a prominent Eastern refiner by Wyatt Metal & Boiler Works.

The above case is not unusual. It is typical of the results achieved with newly developed, more efficient processing equipment. And wherever design, fabrication and materials selection must be critically coordinated, you will find the economical answer in applied *Lukenomics*. For Lukenomics combines the experience of designers, engineers and equipment builders with Lukens' knowledge of materials and their application, gained over 140 years as the world's leading producer of specialty steel plates, heads and steel plate shapes.

You'll find it pays to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them, or write our Manager of Marketing Service, stating your problem. Lukens Steel Company, 402 Lukens Building, Coatesville, Pa.

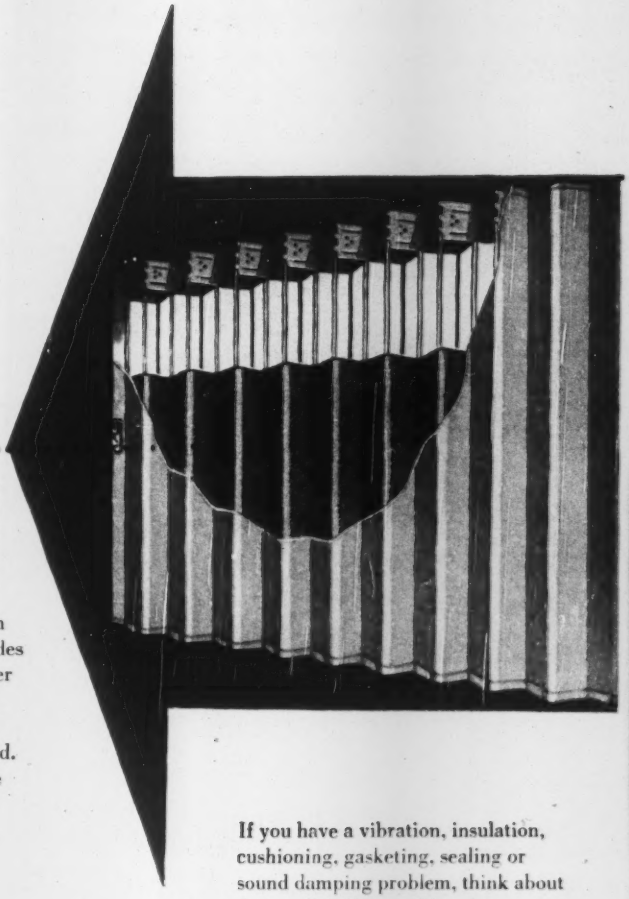
LUKENS

LUKENS STEEL COMPANY

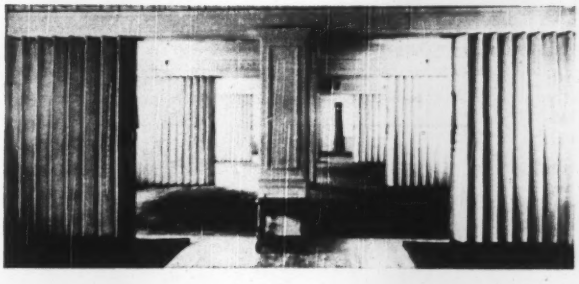
BETTER PRODUCTS FOR BETTER EQUIPMENT

To an imaginative design engineer...

Spongex cellular rubber *sound insulates Modernfold Doors.....*



New Castle Products make the Modernfold accordion-like partition and closure which temporarily divides large rooms into two or more smaller ones. A sound retarding lining for installation in schoolrooms, offices and hotel banquet rooms was needed. In addition to deadening sound, the lining had to be flexible, durable, lightweight, small in bulk, free of dust and dirt, and economical. Spongex cellular rubber, in sheet form, answered their every need.



If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application. We welcome new problems.

Technical Bulletin on Sponge Rubber available upon request.

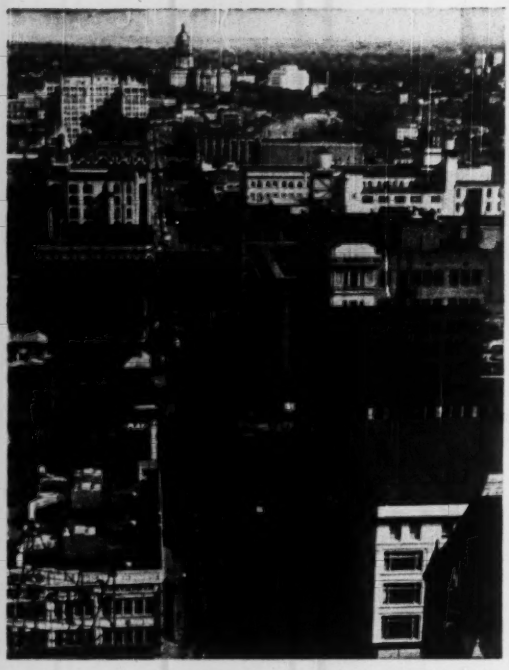
The World's Largest Specialists in Cellular Rubber

SHEETS • CORDS • TUBING • STRIPS • MOLDED OR DIE-CUT SHAPES AND FORMS.

THE SPONGE RUBBER PRODUCTS COMPANY

301 Derby Place, Shelton, Conn.

American Blower—a time-honored name in air handling



In Denver, as in other cities, American Blower Air Handling Products serve commerce, industry and public utilities. For air handling data in the Denver area, call American Blower —Main 3179. In other cities, consult your phone book.

Look before you buy. Comparison tests prove the superiority of American Blower Products. There's a big difference in quality, design, quietness, operating costs and efficiency between American Blower and other air handling equipment.

Air is free . . . use it profitably!

THERE *is* a big difference in air handling equipment.

Quality of workmanship, performance and cost of operation, as well as the experience and integrity of the manufacturer. These are all important factors to consider when buying equipment for handling air.

Take fan ratings, for example. All American Blower Air Handling Equipment is tested and rated in accordance with the Standard Test Code as adopted jointly by the N.A.F.M. and the American Society of Heating and Ventilating Engineers. All ratings are Certified.

These tests are being made continuously in our laboratories built exclusively for this purpose and containing every modern type of equipment for research and testing.

To buyers of air handling equipment, whether it be power plant equipment—mechanical draft fans, fly ash precipitators, Gyrol Fluid Drives for fan control and boiler feed pumps, or air handling equipment for any need—these plus values insure longer, more dependable service and lower operating costs.

Our nearest branch office will give you full data.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

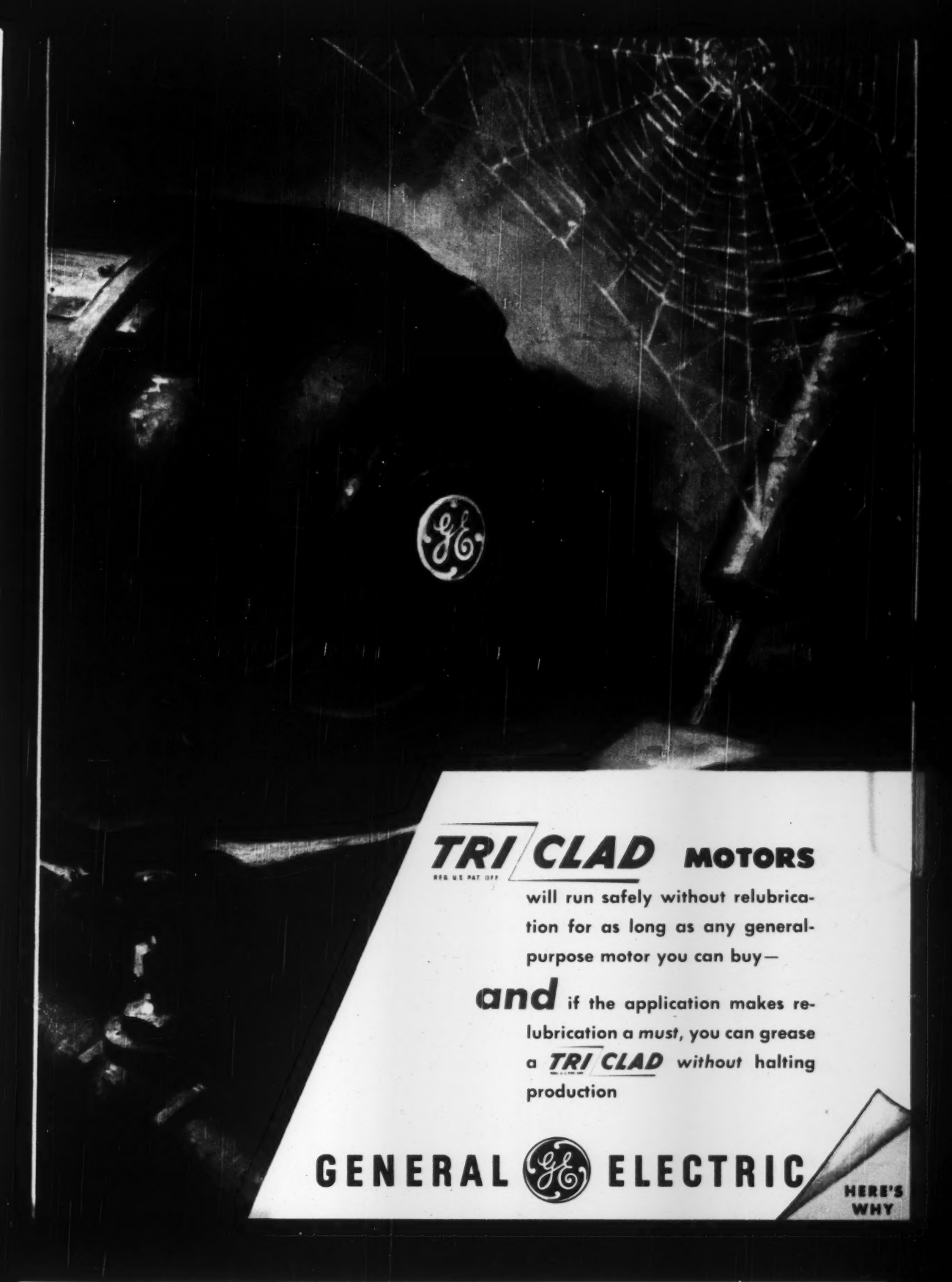
YOUR BEST BUY

AMERICAN BLOWER

AIR HANDLING EQUIPMENT

Serving home and industry

AMERICAN STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON


TRI CLAD MOTORS
REG. U.S. PAT. OFF.
will run safely without relubrication for as long as any general-purpose motor you can buy—
and if the application makes relubrication a *must*, you can grease a TRI CLAD *without* halting production
GENERAL ELECTRIC
HERE'S WHY

TRI CLAD MOTORS will run safely without relubrication for as long as any general-purpose motor you can buy—

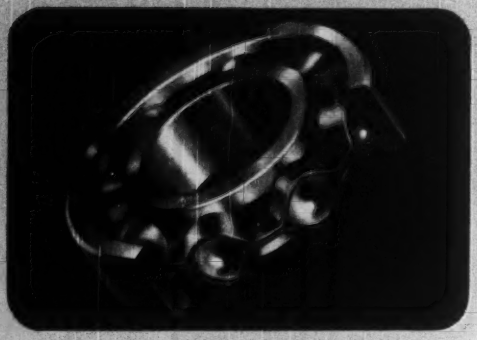
Tri-Clad extra lubrication "protection" can save you money because:

1. Tri-Clad's oversize grease reservoir and the heaviest standard-service bearings mean you do not have to bother with greasing between motor check-ups.

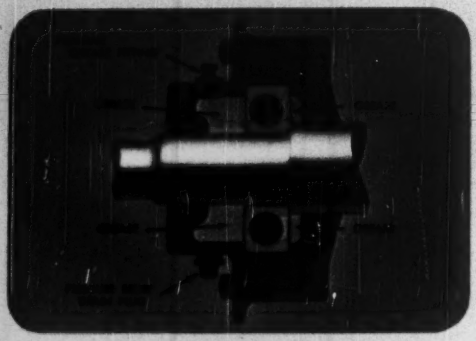
2. When relubrication is needed on those tough applications, you can grease a Tri-Clad without interrupting production-line operations.

Tri-Clads are grease-gun easy to lubricate *on the job*. Moreover, a Tri-Clad motor will run safely where an ordinary motor would fail. Chances are you'll be spared the cost of a "special" motor.

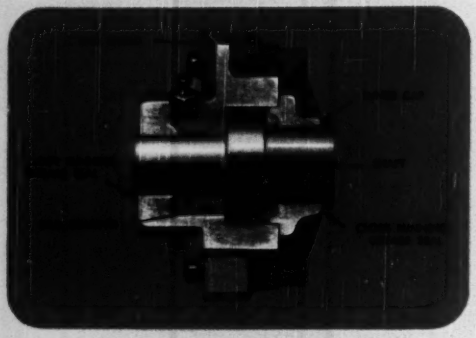
YOU BE THE JUDGE! The best way to prove to yourself that Tri-Clad gives you the most for your motor dollar is to contact your local G-E office. Tri-Clad stocks are complete. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



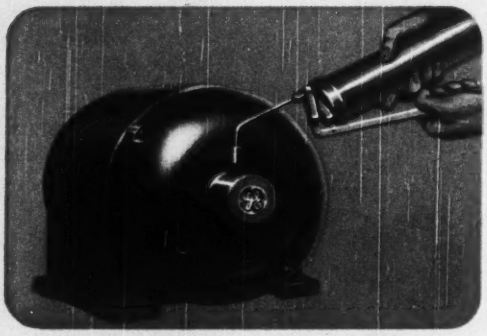
1 **EXTRA BEARING PROTECTION** — Tri-Clad gives you extra bearing protection because heaviest standard-service bearings are carefully selected to withstand severe loads for long periods.



2 **EXTRA GREASE** — Four times the ordinary amount of grease is packed into the large Tri-Clad grease reservoir. Since bearing life depends on grease, this means that Tri-Clad motors will run safely for years — for as long as any general-purpose motor you can buy.



3 **SEALED-IN BEARINGS** — Bearings and grease are completely sealed in a cast housing with long running seals for extra protection from dirt, dust, and lubricant leakage.



4 **PRESSURE-RELIEF GREASING** — An efficient system of pressure-relief lubrication (with standard fittings) enables a Tri-Clad motor to be quickly and easily greased on the job when and if it's needed.

GENERAL ELECTRIC

ASME GUIDE TO

19th NATIONAL POWER SHOW

National Exposition of Power and Mechanical Engineering

Auspices ASME in conjunction with Annual Meeting

Grand Central Palace, New York, N. Y., November 27 to December 2

Three Floors of Exhibits This Year **Exhibitors List Begins on Page 88**

This year's Exposition under the auspices of The American Society of Mechanical Engineers will be at its traditional location in Grand Central Palace with over 300 exhibitors occupying three floors showing latest equipment used throughout the entire mechanical engineering field. The Exposition reveals many striking advances made all along the line since the last Power Show, two years ago.

A large portion of the exhibits will deal with fuels, fuel handling and combustion. Apparatus particularly appropriate to the problem of smoke suppression, a live issue in many communities, include oil and coal handling equipment, piping, pumps and burners; grates, fire walls and insulating materials, stokers, draft equipment, fire and draft controls.

One group of exhibits consists of dust separating equipment including a new type shown for the first time at the exposition.

Within the scope of the exposition are thousands of highly specialized components of big power plants; also hundreds of smaller units for individual power or process steam supply.

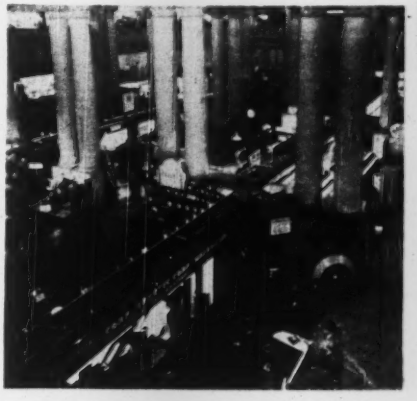
Included also is a wide range of auxiliary equipment and instruments suitable for all manner of industrial plants as well as generating stations.

The array of electrical apparatus is exceedingly comprehensive. Machine tools and tool-room equipment are varied and packed with innovations.

Numerous displays have been developed especially for educational purposes. One of these will be staged by the Tubular Exchanger Manufacturers Association. Another is the model of the new Hamilton-Moses Steam Electric Station of the Arkansas Power & Light Company, consisting of two units with a total capacity of 130,000 kw.

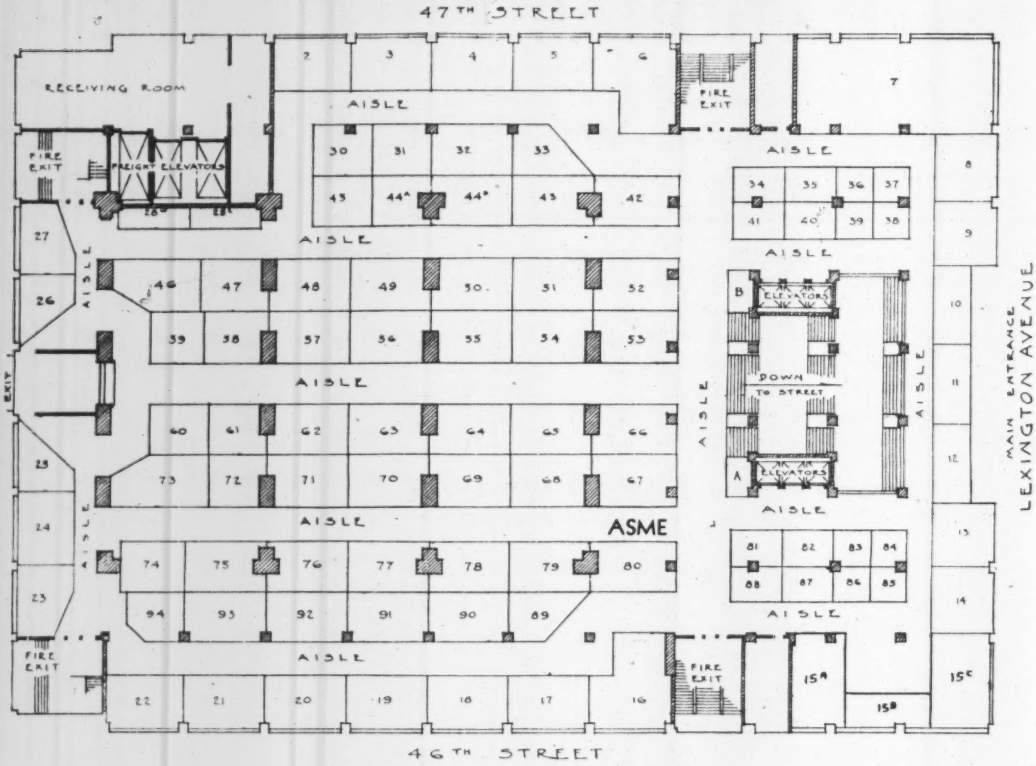
The Exposition will be open from Monday, November 27th to Saturday, December 2nd inclusive. Opens Monday at 2 P.M.

and then daily from 11 A.M. to 10 P.M.; except Wednesday and Saturday closes 6 P.M. As in previous years, the Exposition is being held the same week as the ASME Annual Meeting (Hotel Statler). Tickets of admission can be had without charge at the Annual Meeting and Society Headquarters. ASME Members are especially invited to visit the ASME Booth (No. 80) near the front entrance where information regarding ASME activities and publications will be available.



ASME Guide To 19th NATIONAL POWER SHOW

FIRST FLOOR—Booth Nos. 2 to 94



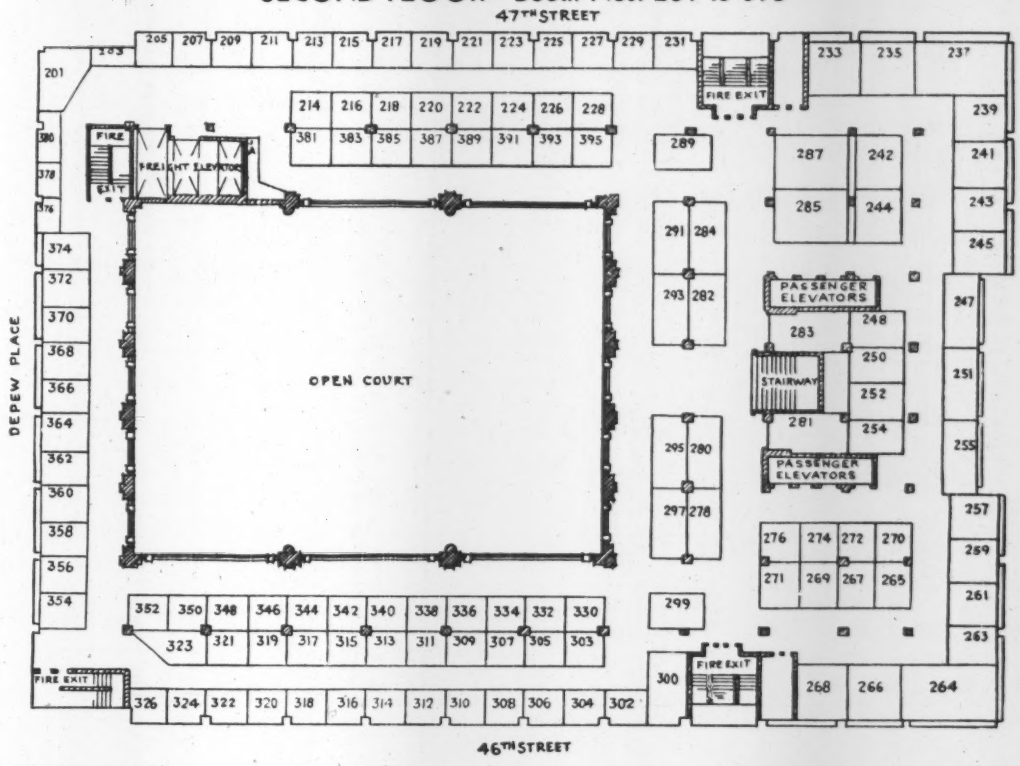
LIST *of* EXHIBITORS

(Corrected to October 27, 1950 from list supplied by International Exposition Co.)

	Booth
Aerodyne Atlantic Corp.	7W
Aerotec Corp.	51
Allen-Bradley Co.	205–213
Allis-Chalmers Mfg. Co.	3–5
Allis, Louis, Co.	320, 322
American Brass Co.	56, 57
American Chain & Cable Co., R-P&C Valve Div.	71
American Chain & Cable Co., Wright Hoist Div.	280
American Flexible Coupling Co.	528
American Hydrovac, Inc.	15A
American Pulley Co.	274, 276
American Pullmax Co.	409
American Society of Mechanical Engineers	80
ASME Mechanical Catalog and Directory	80
Ames Iron Works	77
Ampco Metal, Inc.	229, 231
Amplex Mfg. Co., Sub. of Chrysler Corp.	547, 548
Anderson, V. D., Co.	83
Armstrong & Sons	501
Armstrong Machine Works	330, 332
Armstrong Steam Trap Co.	330, 332
Arrow-Hart & Hegeman Electric Co.	512, 513
Ashton Valve Co.	59
Atlantic Gear Works	389, 391
Atlas Press Co.	403–406
Atlas Roller Chain & Mfg. Co.	437, 438
Atlas Valve Co.	224
Automatic Switch Co.	550, 551
Bailey Meter Co.	54, 55
Baltimore & Ohio Railroad Co.	250–254
Barco Mfg. Co.	270
Barkelew Electric Mfg. Co.	530–532
Barrett-Cravens Co.	73
Bean, John, Div., Food Machinery & Chemical Corp.	272
Beemer Engineering Co.	547, 548
Belco Industrial Equipment Division Inc.	235
Beltran Associates, Inc.	502
Berkray Products Co.	482
Best, W. N., Combustion Equipment Co.	556, 557
Biddle, James G., Co.	354
Black & Decker Mfg. Co.	533, 534
Black, Sivalls & Bryson, Inc.	542
Blackburn-Smith Mfg. Co.	76
Bond, Charles, Co.	221, 223
Bonner & Barnewall, Inc.	443
Boston Gear Works, Div. Murray Co.	287
Botfield Refractories Co.	90
Bowser, Inc.	561, 562
British Industries Corp.	483, 486
Brooks Shaper Co.	483, 486
Brown Boveri Corp.	36, 37
Brown Instrument Div., Minneapolis-Honeywell Regulator Co.	30, 31
Browne, William J.	510, 511
Buell Engineering Co.	72
Buffalo Meter Co.	69
Builders-Providence, Inc.	93, 94
Butler De-Scaler Corp.	476
Cambridge Instrument Co.	381, 383
Centrifuge Mechanical Equipment Co.	76
Chapman Valve Mfg. Co.	46, 47
Chase Chemical Co.	444
Chicago Metal Hose Corp.	244
Chiksan Co.	454, 455
Clark Mfg. Co.	564
Clements Mfg. Co.	563
Cleveland Worm & Gear Co.	19
Cleworth Publishing Co.	460
Clinton Machine Co., Warner Div.	414
Clipper Belt Lacer Co.	313
Coen Burner Sales Co.	226, 228
Coen Co.	226, 228
Commander Mfg. Co.	487, 488
Condenser Service & Engineering Co.	76
Congress Drives Div., Tann Corp.	437, 438
Cramer, R. W., Co.	549
Crane Co.	53
Crosby Steam Gage & Valve Co.	56
Cullman Wheel Co.	437, 436
Cutler-Hammer, Inc.	291, 293
Cyclotherm Corp.	15C
DCMT Die Casting Machine Co.	483, 486
DCMT Sales Corp.	483, 486
Dake Engine Co.	403–406
Dampney Co. of America	62
Danish Transmission Co.	437, 438
Dayton Rubber Co.	297
DeLaval Separator Co.	92
DeZurik Shower Co.	305
Diamond Expansion Bolt Co.	457
Doall Eastern Co.	496, 497
Dowell, Inc.	423, 424
Drew, E. F., & Co.	434
Durant Insulated Pipe Co.	502
Durkee-Atwood Co.	437, 438
Duro Metal Products Co.	482
Dykman Mfg. Corp.	510, 511
Eagle-Picher Sales Co.	324, 326
Eagle Signal Corp.	530–532
Edge Moor Iron Works, Inc.	76
Edward Valves, Inc.	26, 27
Elastic Stop Nut Corp. of America	474, 475
Electra Motors, Inc.	510, 511
Electric Controller & Mfg. Co.	427, 428
Electrical World	201
Elenite Products, Inc.	439
Elliott, B. & Co., Ltd.	479, 480
Elliott Mfg. Co.	467
Energy Control Co.	69
Engineer Co.	247
Ernst Water Column & Gage Co.	A-Main Fl.
Everlasting Valve Co.	41
Fairbanks Co.	78
Fairbanks, Morse & Co.	264–268

ASME Guide To 19th NATIONAL POWER SHOW

SECOND FLOOR—Booth Nos. 201 to 395



Fairfield Engineering Co. 312, 314
Falstrom Co. 543, 544
Famco Machine Co. 537-539
Farris Engineering Corp. 84
Farval Corp. 19
Federal Electric Products Co. 342, 344
Fitz-U Co. 516, 517
Flexitallic Gasket Co. 285
Foley Mfg. Co. 299
Food Machinery & Chemical Corp., John Bean Div. 272
Foote Bros. Gear & Machine Corp. 214, 216
Foster Engineering Co. 38, 39
Foxboro Co. 91
Fuller Co. 251
Furnas Electric Co. 530-532

Garlock Packing Co. 278
Gates Rubber Co. 315, 317
General Chain & Belt Co. 446-450
General Controls Co. 321
General Power Plant Corp. 234
Glasfloss Div., Tilo Roofing Co. 432
Gordon, James T., Co. 19
Graham Transmission, Inc. 425, 426
Graver Water Conditioning Co., Div. of Graver Tank & Mfg. Co. 453
Greene, Tweed & Co. 420
Grinnell Co. 67
Gulf Oil Corp. 261, 263

Hahn-Pitz Corp. 15A
Harbison-Walker Refractories Co. 14
Hays Corp. 68
Heacon, Inc. 43
Heating, Piping & Air Conditioning 338
Hed-Wick & Co. 182
Hilliard Corp. 229, 231
Hills-McCanna Co. 265, 267
Homestead Valve Mfg. Co. 217, 219
Howell Electric Motors Co. 530, 532
Hungerford & Terry, Inc. 554, 555

Industrial Press 421
Industrial Pyrometer & Supply Co. 374
Industry and Power 311
Institute of Patent Research and Development, Inc. 565
Insto-Gas Corp. 540
Instrument Service Co. 76
Instrumente Publishing Co. 506
Insulating Concrete Corp. 304
International Nickel Co. 8, 9
Irving Subway Grating Co. 441

Janney Cylinder Co. 242
Jenkins Bros. 74, 75
Jerguson Gage & Valve Co. 346
Johns-Manville Sales Corp. 20
Johnson Corp. 334, 336
Johnson Mfg. Corp. 412, 413
Jones, E. H., Co. 483, 486

Kaye & MacDonald, Inc. 308, 310
Kaylo Div., Owens-Illinois Glass Co. 241
Kearney & Trecker Corp., Walker-Turner Div. 493, 495
Keasbey & Mattison Co. 2
Keeney Publishing Co. 338
Kent Co. 508, 509

Lapp Insulator Co. 525
Lee Engineering Co. 76
Leeds & Northrup Co. 22
Leibfried, C. H., Mfg. Corp. 518
Leslie Co. 28W
Lietke Diesel & Compressor Co. 552, 553
Livingstone Engineering Co. 203, 380
Logan Engineering Co. 482
Lonergan, J. E., Co. 307
Lord Mfg. Co. 558
Lovejoy Flexible Coupling Co. 461
Loyal Textile Machinery Corp. 15A
Lunkenheimer Co. 52
Lyon-Raymond Corp. 559, 560

McClave Co. 81, 82
McGraw-Hill Publishing Co. 42, 201
Magnetic Fluid Corp. 507
Magnetrol Inc., Div., Fred H. Schaub Engineering Co. 303
Master Lubricants Co. 437, 438
Maurey Mfg. Corp. 437, 438
Mechanical Engineering 80
Melrath Supply & Gasket Co. 323
Manning, Maxwell & Moore, Inc. 89
Marsh Stencil Machine Co. 445
Martindale Electric Co. 402
Mercoid Corp. 85, 86
Merriam Instrument Co. 348
Metallizing Co. of America 429
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 527
Modern of Coventry 483, 486
Milton Roy Co. 433
Minneapolis-Honeywell Regulator Co., Brown Instruments Div. 30, 31
Moore, J. Arthur, Co. 348
Mundet Cork Corp. 255

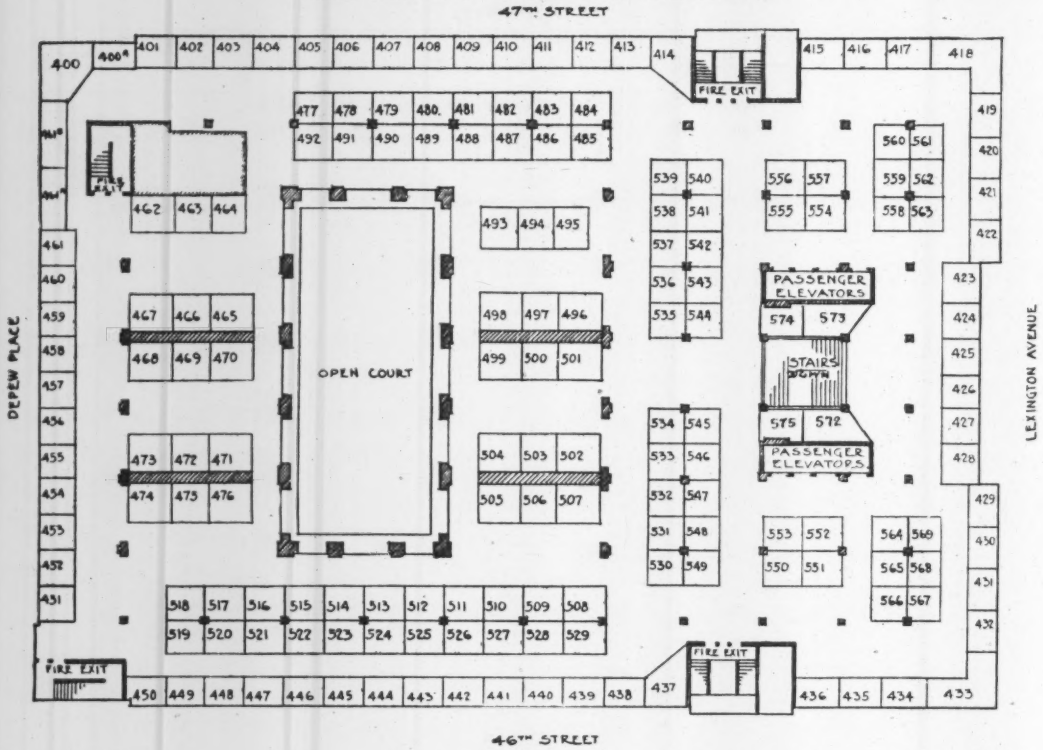
Niagara Blower Co. 23, 25
Nicholson, W. H. & Co. 440
Nickel Cadmium Battery Corp. 215
Nordstrom Valve Div., Rockwell Mfg. Co. 26, 27
Norton Co. 415, 416
Nugent, Wm. W. & Co. 259

Ohio Injector Co. 58
Olsen, Tinius, Testing Machine Co. 17W
Omega Machine Co. 94
O'Neil-Irwin Mfg. Co. 400, 400A, 401B
Operating Engineer 42
Orr & Sembower, Inc. 16
Oster Mfg. Co. 499, 500
Owens-Illinois Glass Co., Kaylo Div. 241

Palmer Thermometers, Inc. 348
Parker Appliance Co. 21
Parker Machine Co. 481
Paulson, Thomas & Son 419
Penberthy Injector Co. 509
Penn Industrial Instrument Co. 69
Perfecting Service Co. 523
Permutit Co. 79
Phelps, Charles C., Co. 440, 523

ASME Guide To 19th NATIONAL POWER SHOW

THIRD FLOOR—Booth Nos. 400 to 575



Philadelphia Gear Works	44B
Pitt Foundry, Inc.	15A
Plant Engineering	12
Powell, Wm., Co.	63
Power	42
Power Equipment	460
Power Engineering	12
Power King Tool Corp.	403-406
Prat-Daniel Corp.	50
Preferred Utilities Mfg. Corp.	60, 61
Proportioneers, Inc.	93
Pyramid Instrument Corp.	326
Quigley Co.	300, 302
R-P&C Valve Div. American Chain & Cable Co.	71
Randall Graphite Bearings, Inc.	437, 438
Ray Oil Burner Sales, Inc.	316, 318
Reeves Pulley Co. of N. Y.	34, 35
Reintjes, Geo. P., Co.	33
Republic Flow Meters Co.	6
Republic Steel Corp., Steel & Tubes Div.	13
Research Corp.	18
Rhoads, J. E. & Sons	269, 271
Ribble, C. H., Co.	530-532
Richardson Scale Co.	385, 387
Ric-Wil Co.	48, 49
Ridge Tool Co.	462-464
Robinson, John R.	541
Robinson Orifice Fittings Co.	348
Rockwell, W. S., Co.	520
Rockwell Mfg. Co.	26, 27
Rockwood Sprinkler Co.	567, 568
S & S Machinery Co.	479, 480
Sandersen Sales Service	545, 546
Sanson, Henry E. & Sons	442
Santa Fe Tank & Tower Co.	248
Sarco Co.	11
Schaub, Fred H., Engineering Co.	17E
Schaub, Fred H., Engineering Co., Magnetrol, Div.	303
Scherr, George, Co.	393, 395
Schrader's, A., Son, Div. of Scovill Mfg. Co.	535, 536
Scovill Mfg. Co.	70
Service Machine Co.	489, 490
Sheldon Machine Co.	477, 478
Shell Oil Co.	284
Sinex Projects, Inc.	566
Skilsaw, Inc.	491, 492
Smith, Winfield, H., Corp.	510, 511
Smith & Serrell, Inc.	422
Socony-Vacuum Oil Co.	364-368
Southern Power and Industry	40
Sparling Meter Co.	243, 245
Spence Engineering Co.	87
Spencer Turbine Co.	282
Squires, C. E., Co.	468
Star Expansion Bolt Co.	410
Star Expansion Products Co.	410
Star Fuse Co.	569
Steel & Tubes Div., Republic Steel Corp.	13
Stephens-Adamson Mfg. Co.	218, 220
Stiebt, Herman H., Co.	519
Strachan-MacKoe Corp.	229, 231
Strong, Carlisle & Hammond Co.	503, 504
Superior Combustion Industries, Inc.	7E
Taylor Instrument Cos.	370, 372
Technical Publishing Co.	12
Tek Bearing Co.	356, 358
Texas Co.	295
Thermix Corp.	43
Thermobloc Div., Prat-Daniel Corp.	50
Thomas Flexible Coupling Co.	465
Tide Water Associated Oil Co.	10
Tilo Roofing Co., Glasfloss Div.	432
Titeflex, Inc.	360, 362
Tripard Mfg. Co.	445
Troy Engine & Machine Co.	88
Tubular Exchanger Manufacturers Association	237
Uehling Instrument Co.	340
Union Asbestos & Rubber Co., Insulation Div.	350, 352
U. S. Electrical Motors, Inc.	28G
United States Hoffman Machinery Corp.	435, 436
Van Dorn Electric Tool Co.	533, 534
Velan Engineering Co.	522
Vickers Electric Div., Vickers, Inc.	417
Vincent-Gilson Engineering Co.	312, 314
Vogt, Henry, Machine Co.	44A, 45
Voss, J. H. H., Co.	430, 431
Waldes Kohinoor, Inc.	451, 452
Waldron, John, Corp.	225
Walker-Turner Div. of Kearney & Trecker Corp.	493-495
Wallace & Tiernan Products, Inc.	257, 259
Walworth Co.	32
Warner Div., Clinton Machine Co.	414
Watson-Stillman Co.	227
Waugh Equipment Co.	505
Wetzler Clamp Co.	407
Wheelco Instruments Co.	222
Williams, J. H., & Co.	408
Wing, L. J., Mfg. Co.	64
Wright-Austin Co.	28E
Wright Hoist Div., American Chain & Cable Co.	280
Yale, V. Paul, Associates	461A
Yarnall-Waring Co.	65, 66
Yorkshire Copper Works, Ltd.	229, 231
Zink, John, Co.	348
Zurn, J. A., Mfg. Co.	529

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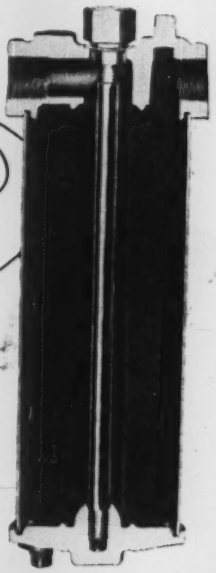
no matter how much it eats and drinks



Put the Cuno MICRO-KLEAN filter on almost any kind of a diet . . . and it will stay healthy longer than any micronic filter you know of.

Handling a wide range of fluids at a wide range of flow rates . . . the MICRO-KLEAN won't *shrink* or *swell* or *channel*. So there's no place for the fluid to go except where it's supposed to . . . through the cartridge.

Its dirt capacity is *double* that of any comparable filter—so its life is that much *longer*.

Finally, you can install it—inside or outside your equipment—with no trouble at all, because it takes up less space.

Check the box nearby for an explanation of MICRO-KLEAN's exclusive performance.

No Fluid Is Better Than Its Filtration

EXPLANATION

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Because the fiber structure is resinous-impregnated and polymerized, and resists any deteriorating effects of most fluids and contaminants.

Why does MICRO-KLEAN *have double dirt capacity?*

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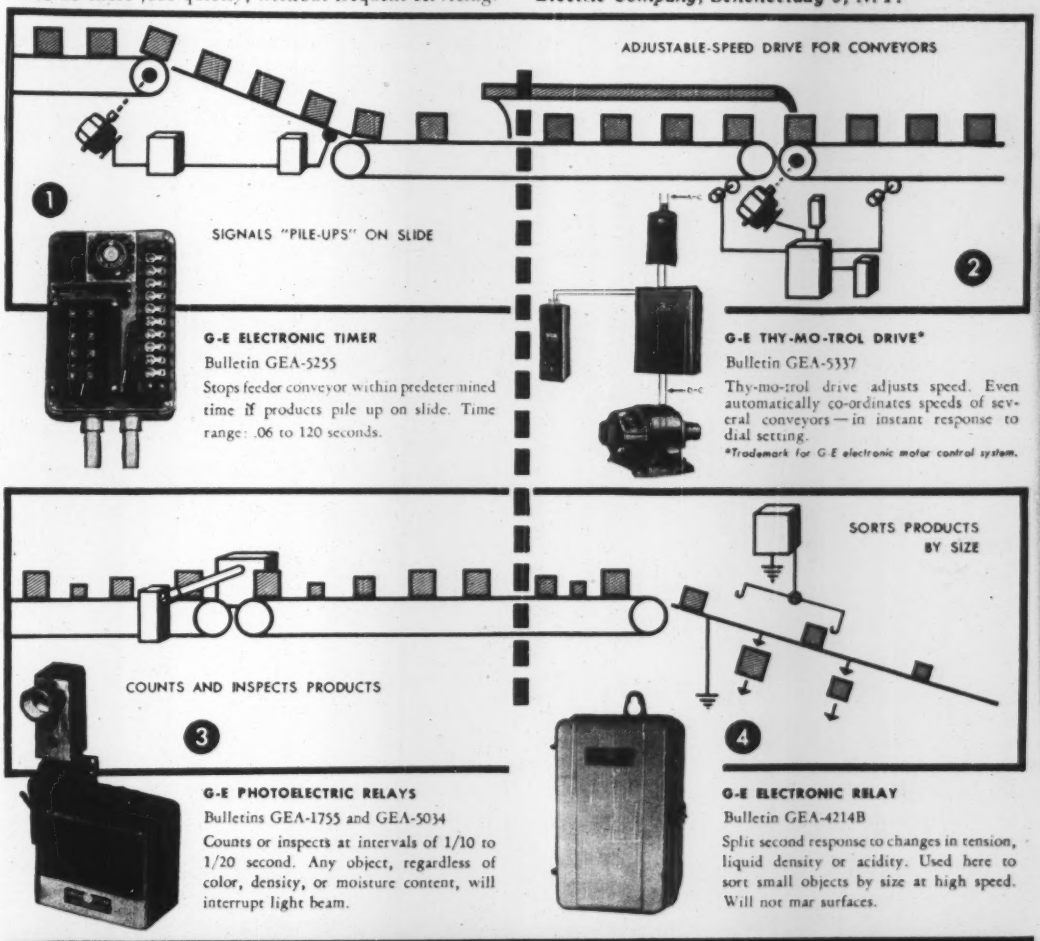

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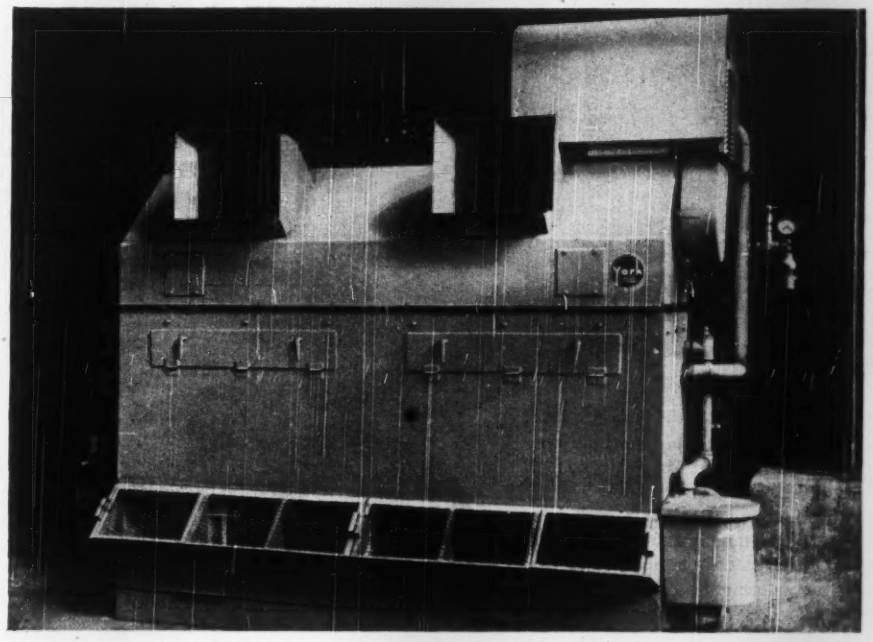

FOR many years Revere has furnished the York Corporation, York, Pa., with copper and brass for use in its air conditioning, refrigeration and heating equipment. Engineers at York tell us that during that time they have learned to depend on Revere Products for high quality and uniformity of metal, correct temper, and strict adherence to specifications.

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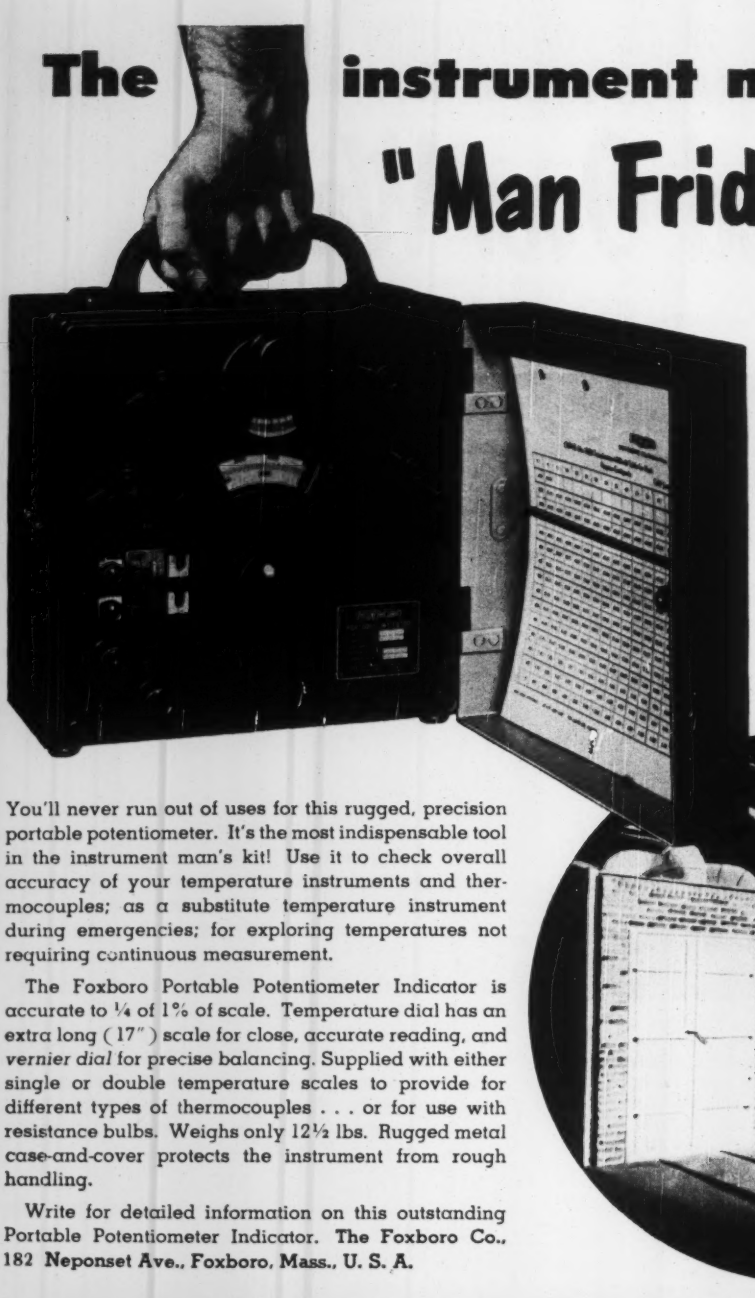

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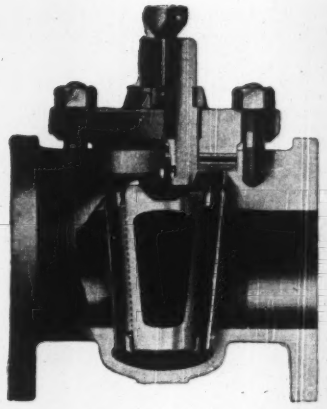

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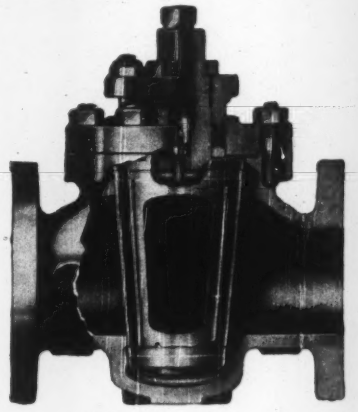
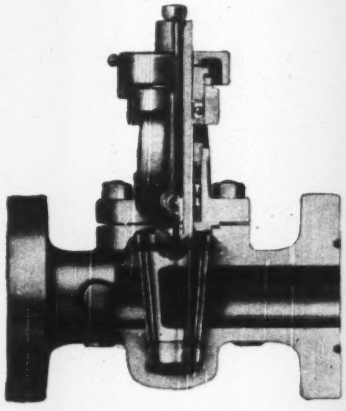


Regular Gland Type



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When handling acids, condensates, dyes, oils, solvents, solutions, slurries and hundreds of similar "troublesome" liquids, you get better control, more dependable service and lower operating costs with Walworth Lubricated Plug Valves.

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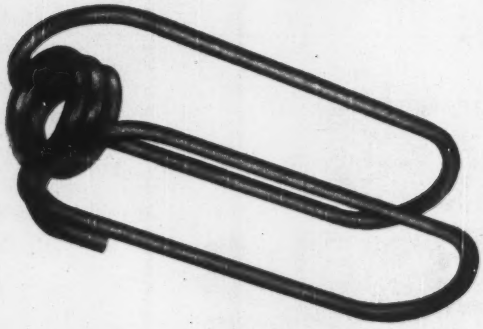

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CHROME-MOLY STEAM VALVES

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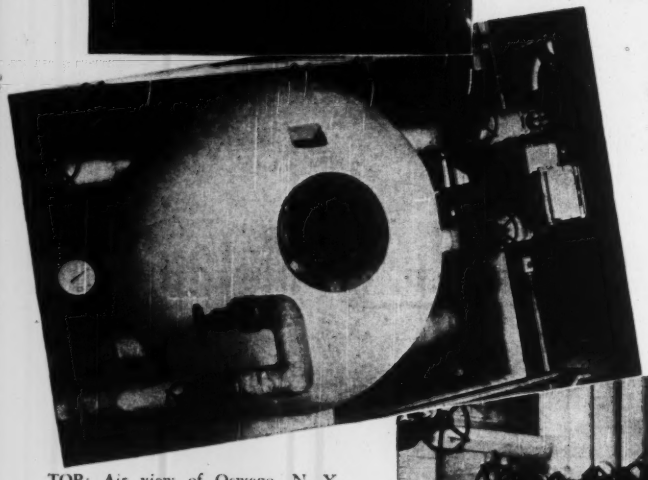
Oswego, N. Y. Station of

* NIAGARA MOHAWK POWER CO.



Leading central stations know and trust Vogt drop forged steel chrome-moly valves in their toughest high pressure and high temperature services.
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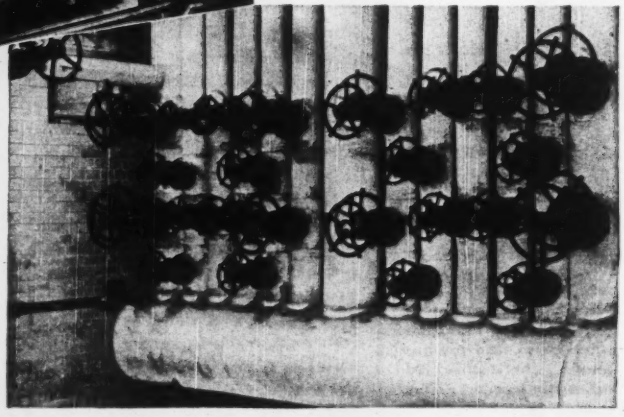

TOP: Air view of Oswego, N. Y. Station of Niagara Mohawk Power Co.

CENTER: Valves on main drum of 875,000 pounds per hour steam generator.

RIGHT: Drains from main steam, attemperator, and superheater lines employ a maze of valves.

NEW CATALOG F-9
Consult its 400 pages for the complete Vogt line of drop forged steel Valves, Fittings and Flanges for steam, water, oil, gas, air and refrigeration services.

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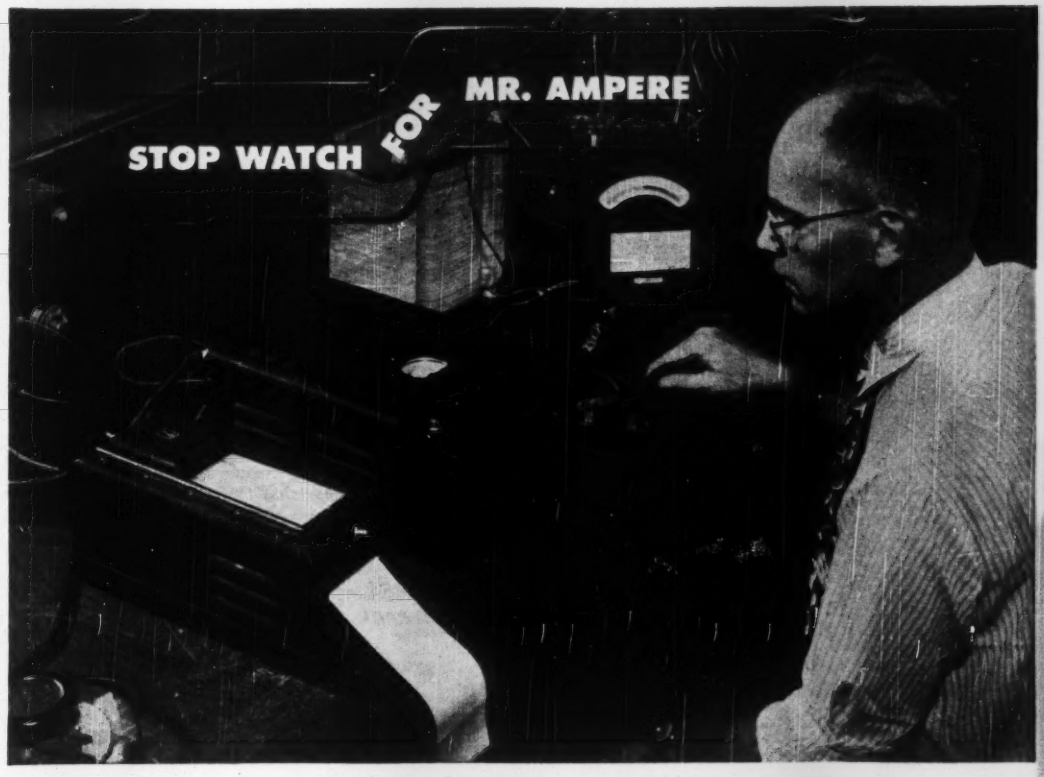

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Just note some of the Bundyweld high spots that help make Bundyweld a favored tubing.

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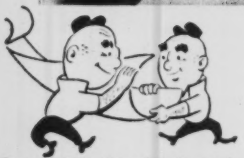
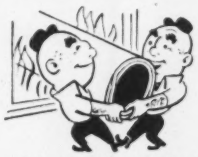
NOTE the exclusive patented Bundyweld beveled edge, which affords a smoother joint, absence of bead and less chance for any leakage.

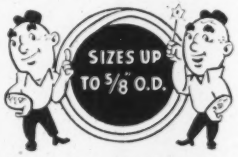


First a single strip of basic metal, coated with a bonding metal, is . . .

rolled twice around into a tube of uniform thickness, then . . .

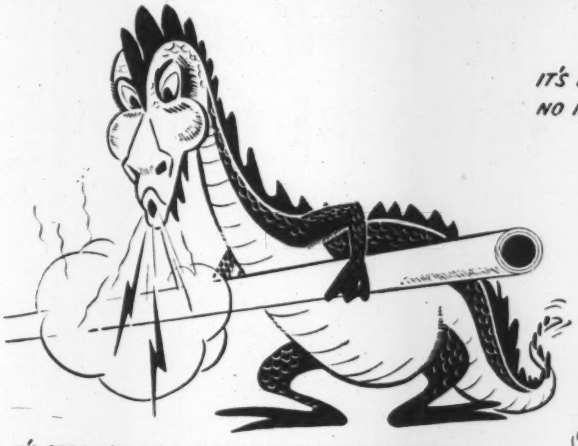


passed through a furnace. Bonding metal fuses with basic metal, presto—



Bundyweld . . . double-walled and brazed through 360° of wall contact.

the favored tubing



IT'S DOUBLE-WALLED FROM A SINGLE STRIP, NO INSIDE BEAD... REAL CRAFTSMANSHIP.

An application of dependable Bundyweld may well pave the way to faster production, lower costs or a sturdier product for you. Just as it already has in pen cartridges, tubular frames, automotive parts, ranges and hundreds of other products. Whatever you make, double-check on double-walled Bundyweld today.

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Use of Bundyweld Tubing in radiant heating systems is growing by leaps and bounds. No leaks! Walls are rolled up tight and brazed through 360° of wall contact. The double wall is extra-strong, yet thinner, too. Conducts heat faster, evenly through every inch of the system. Easily installed, Bundyweld lasts a *housetime*.

IT'S made in Monel, nickel or steel. Adds a plus to a trinket or an automobile. If you need a tubing, there's none so fine To "up" performance, improve design.

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FREE! Why not take a look-see at Bundy's 20-page booklet, complete with facts, figures and suggestions on Bundyweld applications in a wide range of products in the past. It's yours for the asking, and may spark some profitable ideas for you. For booklet or inquiries on use of small-diameter tubing, just get in touch with: ***Bundy Tubing Company, Detroit 14, Michigan.***

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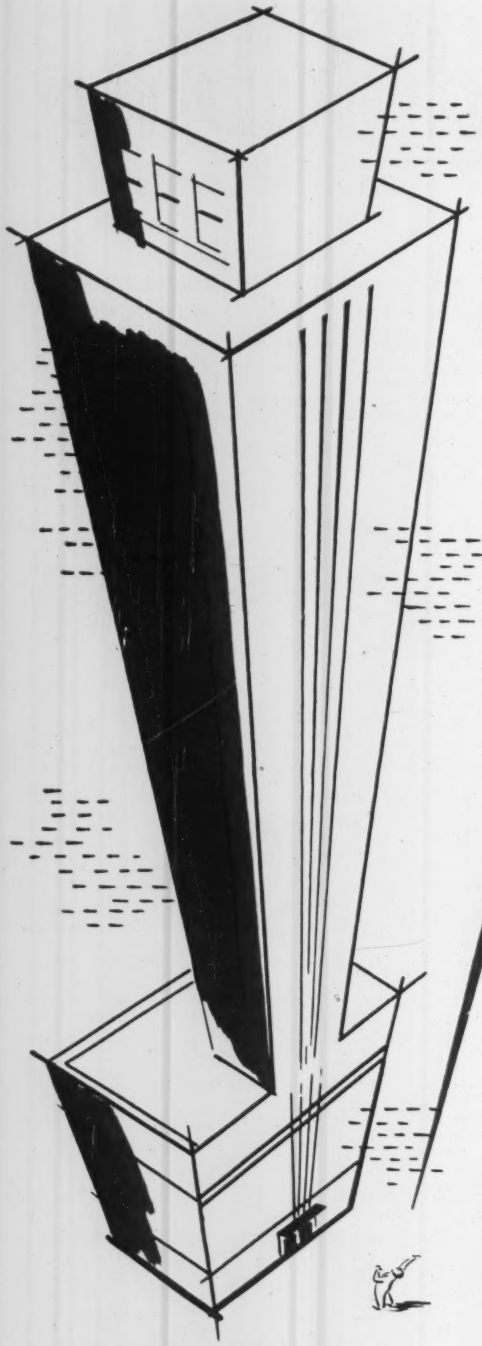

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it wasn't even here this morning

Now, w-a-i-t a minute! That's going a little too far. Maybe we do perform industrial miracles in this America of ours, but we have not gotten around to putting up skyscrapers in *one* working day—not yet anyhow. But we're doing things almost as miraculous as that.

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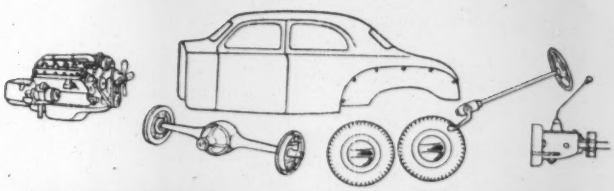
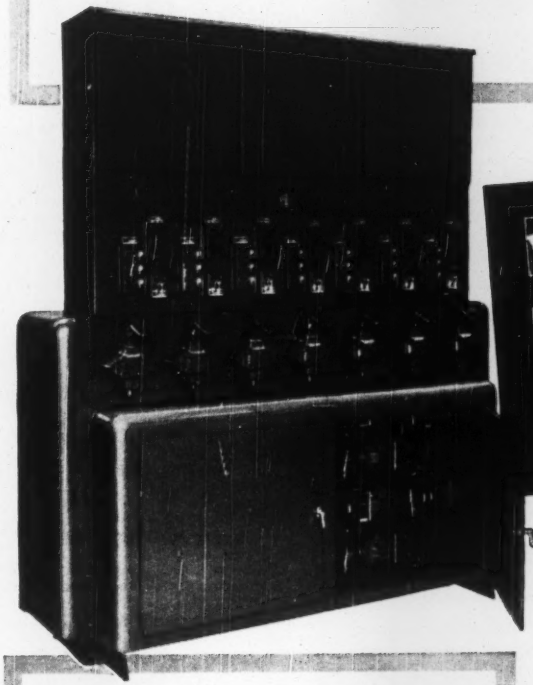


YOU WOULDN'T buy a car this way

. . . so why buy hydraulics piecemeal



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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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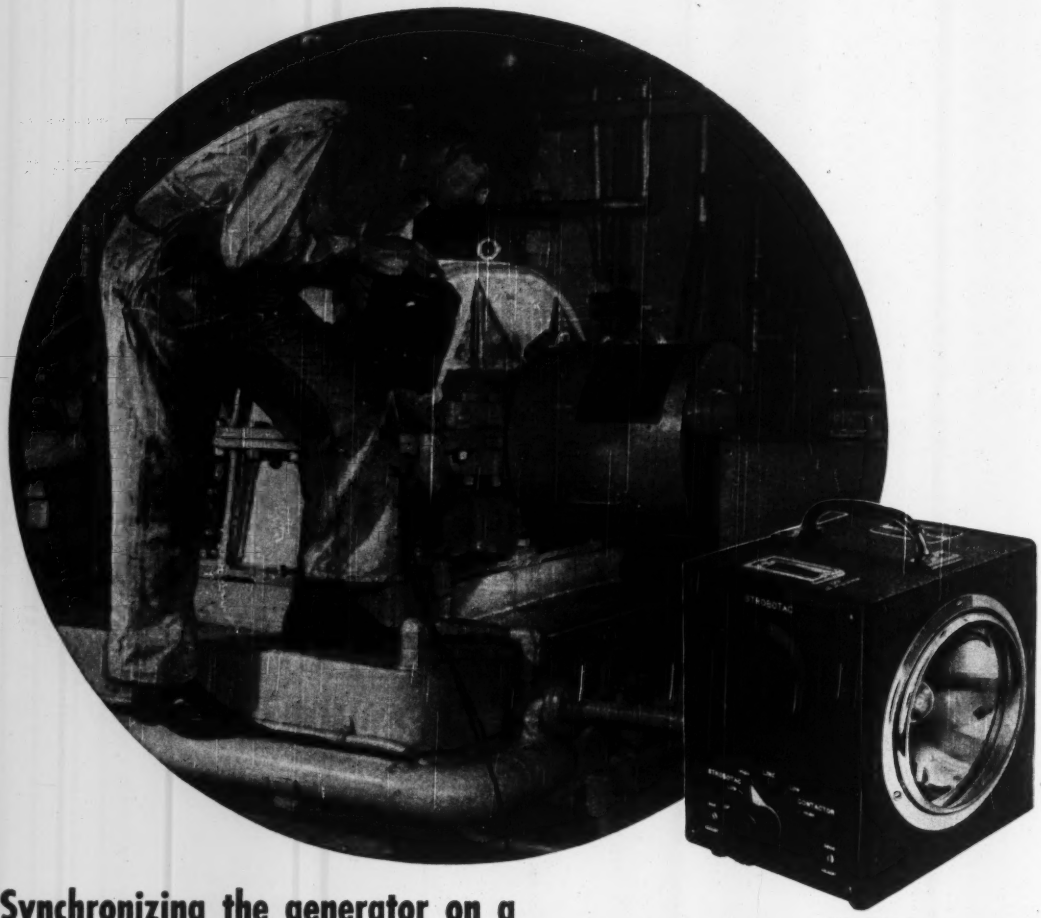

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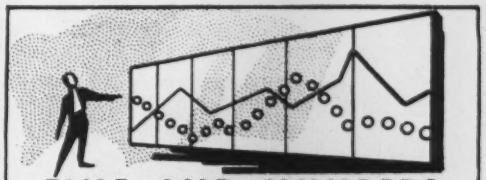

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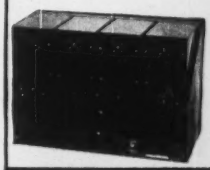

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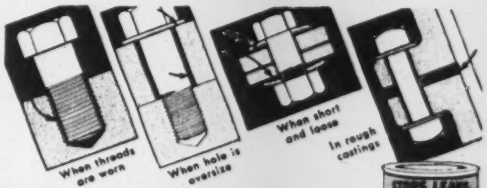

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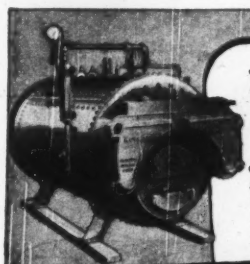
MECHANICAL ENGINEERING
October, 1950 CARD INDEX Vol. 72, No. 10

What Price Speed?, G. Gabrielli and Th. von Kármán	775
Taxes and Economic Incentives, R. E. Freeman	782
Styline the Machine Tool, Frank Burgess and Harold Sizer	783
The Talgo Train, J. M. Gruitch and O. H. Philips	787
Jobs for Young Mechanical Engineers, J. I. Reynolds	792
Smoke-Density Measurement, W. F. Stoecker	793
Properties of Metals at Elevated Temperature, G. V. Smith	799
Postwar Developments in Forest-Products Research, C. A. Rishell	805
The Engineering Teacher, A. A. Potter	809
Editorial	773
Briefing the Record	811
ASME Technical Digest	823
Contents of ASME Transactions	830
Reviews of Books	831
ASME Boiler Code	834
Engineering Profession, News, Notes	836
ASME News	841
ASME 1950 Annual Meeting Program	843
ASME Junior Forum	848
Engineering Societies Personnel Service	856



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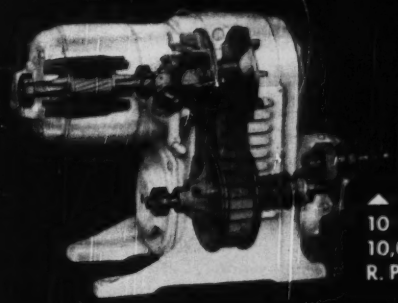
GET 10 HOURS WORK IN 8



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Atlantic Plant: Milford, Conn.
Pacific Plant: Los Angeles 54, Calif.

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LINEAR PACKINGS

The W. H. Nichols Company required special seals, of utmost dependability, for two rather unusual jobs in this pump. LINEAR "Perfectly Engineered Packings" filled the bill and are giving A-1 performance in a critical operation.

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LINEAR

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KUNKLE SAFETY AND RELIEF VALVES

IF SAFETY VALVE

LEAKAGE IS YOUR PROBLEM

. . . KUNKLE offers nylon and stainless steel equipped air and gas valves . . . LEAKPROOF at 93 to 96% of set pressures.

Bronze, iron and steel. Wide range of pressures and temperatures.

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So, to continue the fight, send in your contribution today, please.

buy Christmas Seals!

Because of the importance of the above message this space has been contributed by

MECHANICAL ENGINEERING

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FOR POWER CONTROL DESIGNS

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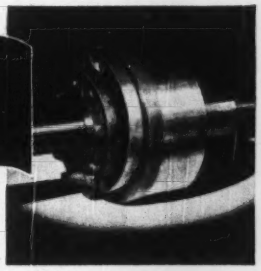
SINGLE
REVOLUTION
CLUTCH



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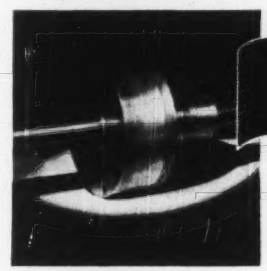

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Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unexcelled for automatic two-speed drives, dual drives, stand-by drives, and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

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A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations; and many other uses.

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MPB makes more than **50** types and sizes of miniature ball bearings

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Typical 1046 valve installation on resistance welder in major automobile plant.

1046 series CRESCENT valves

are piloted piston operated, solenoid controlled 4-way valves.

The solenoids are especially designed for high speed operation of up to 600 cycles a minute, and will not overheat or malfunction in prolonged service of this speed. Test valves have registered over five million cycles without maintenance.

In actual operation on resistance welders in the automotive field, on packaging machines and in many other industrial installations, Crescent valves are making history with their outstanding performance records.

1046 series valves are available in ¼", ⅜", ½", and ¾" pipe sizes.

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BARKSDALE

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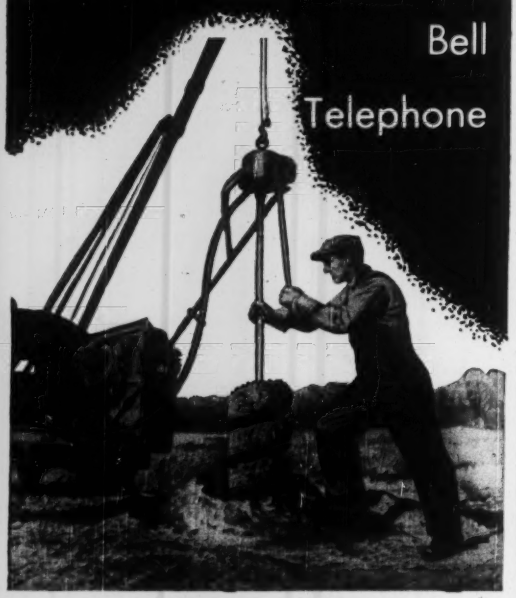
STOW case history #1

STOW *flexible shaft* on the job for Bell Telephone



BELL TELEPHONE CO. experts in rural line maintenance select their equipment for all-around, all-weather, on-the-job dependability. The above illustration shows a STOW Flexible Shaft transmitting power to one of the POST-HOLE DIGGERS used by BELL TELEPHONE CO. in maintaining rural power lines. STOW Flexible Shafting can solve your problems in power transmission. Write today for your handy STOW TORQUE CALCULATOR—and further information on unique applications of **STOW FLEXIBLE SHAFTING!**

Send for your free copy

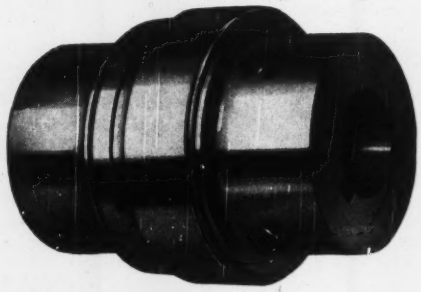
LEARN HOW STOW FLEXIBLE SHAFTS HAVE BEEN SOLVING POWER TRANSMISSION PROBLEMS SINCE 1875.

STOW MANUFACTURING CO.
52 Shear St. Binghamton, N. Y.

NO EXCUSE

for machine down-time due to misalignment—backlash—friction—cross-pull or wear when you use . . . .

LOVEJOY L-R
Flexible Couplings



- No lubrication ever necessary
- No metal-to-metal contact. Resilient, free floating load cushions, suspended between strong metal jaws take up all the wear and punishment.
- No teardown for changing
- Cushions are always in sight.
- Cushions available for ALL service conditions —oil, heat, weather, chemical vapors.

Instantly, permanently, these couplings correct for angular, parallel and combination angular-parallel misalignments. They compensate for unnecessary bearing load and absorb vibration, shock and backlash, thus lengthening bearing life and transmitting smooth, noiseless power.

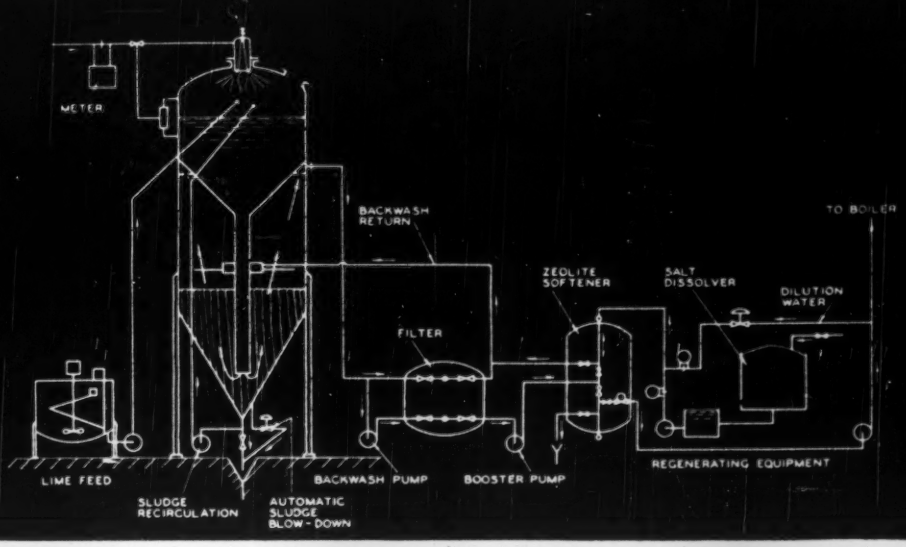
Coupling shown above is type "H" heavy duty.

Write For Catalog With Handy Selector Charts On Couplings From 1/6 To 2500 h.p.

LOVEJOY FLEXIBLE COUPLING CO.
5032 W. Lake St., Chicago 44, Ill.

Also mfrs. Lovejoy Variable Speed Transmissions and Lovejoy Universal Joints

cochrane hot process zeolite water conditioner



1. saves chemicals
The zeolite softener uses salt instead of the more expensive soda ash and phosphates, bringing down the cost of chemicals considerably.

2. saves on capital investment The cost of adding zeolite equipment to a hot process installation is far less than the addition of an independent sedimentation tank and chemical feed for a two-stage phosphate process.

3. lower CO_2 in steam
The lower alkalinity resulting from using lime alone, plus the fact that this alkalinity is all carbonate, causes a reduction in CO_2 generated in the steam.

4. less operating attention The use of the zeolite softener with its simplicity of operation is an advantage which is enhanced by the longer periods between regenerations, due to the lower hardness of the hot process softener effluent.

5. less floor space and head room required
The addition of the zeolite equipment requires less floor space and less head room than that required for two stage phosphate equipment.

6. lower alkalinity The use of lime (or Dolomitic lime) as the sole reagent in the hot process means that the alkalinity can be reduced to about half that obtained with lime and soda ash.

7. only one chemical needed in the hot process It is generally possible to use a single reagent in the hot process, namely lime or Dolomitic lime, precipitating the bicarbonates and magnesium, leaving the remaining hardness to be removed by the more economical zeolite.

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OPPORTUNITIES

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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

POSITIONS OPEN

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.50 a line. $1.25 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $25 per inch per insertion. Maximum size: 1 column, 10 inches deep; 2 columns, 5 inches deep. Copy must reach us not later than the 10th of the month preceding date of publication.

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• • •

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- Microwave Techniques
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- Radar
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- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

NORTH AMERICAN AVIATION, INC.
AEROPHYSICS LABORATORY
Box No. H-4
12214 South Lakewood Blvd.
Downey, California

Wanted for large, modern Wire Mill —Engineer for permanent position, developing, improving, and increasing operating efficiency of Wire Mill equipment including wire drawing, nail, high speed netting, welded fabric, fence, and related Wire Mill machinery. Applicant must be capable of co-ordinating improvements and maintenance with operations, be aggressive, and have supervisional ability.

This is a progressive company undergoing expansion and only a top quality Engineer will be considered.

Plant located West of Mississippi with ideal year round climatic conditions.

Address CA-3334, care of "Mechanical Engineering."

ANALOGUE COMPUTER ENGINEER

Experienced graduate electrical engineer with extensive background in analogue computer development, required to supervise analogue computer section. This engineer must be able to assume full technical responsibility and planning for projects ranging from single equipments to complete system development. Here is a life time opportunity for the individual who can organize a rapidly expanding facility. Submit detailed resumé. Personal interview will be arranged.

ENGINEERING REREARCH ASSOCIATES, INC.
1902 West Minnehaha Avenue
St. Paul 4, Minnesota

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For Mechanical Design and Engineering Studies in connection with Electric Utility work. Should have 15 years' experience in similar work.

***Write to:* Mechanical Engineer, Pennsylvania Power & Light Company, Allentown, Pennsylvania.**

RESEARCH MECHANICAL ENGINEER

Long-range research program of large and progressive manufacturer of air conditioning and refrigeration equipment requires services of mechanical engineer with demonstrated record of creative achievement.

Requirements include excellent fundamental training in heat transfer and fluid flow; experience in research and development of mechanical devices and heat exchange equipment; and the personal qualifications necessary to organize and carry through a program of applied research from general assignment to successful commercial application.

Age from 30 to 45. Salary commensurate with experience and qualifications. Location Central New York.

Please write, stating education, experience, age, record of accomplishment and invention, and salary desired.

Address CA-3338, care of "Mechanical Engineering."

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Physicists and Engineers with advanced experimental and theoretical experience in

- **Nuclear Technology**
- **Solid State Physics**
- **Physical Metallurgy**
- **Power Plant Components**

are desired for research and development work on direct contract with the Reactor Division of the Atomic Energy Commission.

These positions offer unique opportunities for working with a highly trained group of scientists and for participating in theoretical and experimental studies in nuclear reactor technology. The laboratory is located in the Los Angeles area.

Please write to:

NORTH AMERICAN AVIATION, Inc.
Attention: Personnel Manager
ATOMIC ENERGY RESEARCH DEPARTMENT
12214 South Lakewood Blvd.
Downey, California

MACHINE DESIGNERS

A large Middle-west machine tool builder requires the services of several capable machine tool designers with a technical and practical background. Splendid opportunities available for qualified persons. Give complete details of self, education, experience and salary expected.

Address CA-3333, care of "Mechanical Engineering."

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Excellent positions on experimental research and development projects related to intricate electro-mechanical and electronic devices.

Men with advanced degrees or equivalent experience may qualify for permanent positions in our laboratories in New York State.

Give full details of education and experience indicating age and marital status.

Address CA-3336, care of "Mechanical Engineering."

Three Pages of "OPPORTUNITIES" This Month . . . 114-116

Engineers wanted for

MILITARY PROJECTS

at North American Aviation, Inc.
Los Angeles

Excellent openings for qualified

AERODYNAMICISTS
(Design and Research)

STRESS ANALYSTS

AIRCRAFT DESIGNERS
(Electrical, Electro-Mechanical, Structural, Hydraulic, etc.)

and specialists in all other phases of aircraft engineering. Please include summary of experience in reply.

Engineering Personnel Office
Section 4

NORTH AMERICAN AVIATION, INC.
LOS ANGELES INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

Needed At Once

Experienced

PHYSICISTS, CHEMISTS AND ENGINEERS

Mechanical, Electrical, Electronic and Chemical

For Work on an Atomic Energy Project in the San Francisco Bay Area

by

CALIFORNIA RESEARCH & DEVELOPMENT COMPANY

Airmail complete summary education, training, experience, expected salary, and references to Standard Oil Company of California—Employment Office, 225 Bush Street, San Francisco 20, California.

SENIOR MECHANICAL

DESIGN ENGINEER

for a CHEMICAL PLANT

A registered Mechanical Engineer with a B.S. in M.E. with at least 8 years' experience in the petroleum or chemical industry. Must be capable administrator and supervisor.

Experience should include plant design, drafting, estimating, specification writing, plant layout and piping. Preferably married, around 40 years of age. This is a permanent opening with good possibilities.

We are located in a small town in the San Francisco Bay Area. Please write us in detail.

Address CA-3337, care of "Mechanical Engineering"

GRADUATE MECHANICAL ENGINEERS, CHEMICAL ENGINEERS, OR PHYSICISTS

for research design and development work on rockets, rocket components, and guided missiles. Firm academic background in mathematics, hydraulics, thermodynamics and stress analysis necessary. Experienced in the field of rocketry or allied work. Advanced degree desirable.

Applicant must furnish transcripts of academic record, names of four persons familiar with research ability, complete résumé of past experience and salary desired. All correspondence will be kept confidential.

AEROJET ENGINEERING CORPORATION
P. O. Box 296, Azusa, California

ASSISTANT PROFESSOR, also an INSTRUCTOR in Industrial Engineering. Advanced degree and suitable academic or industrial experience in Motion and Time Study, or Personnel Administration, or Production Engineering. Opportunity for advancement. Opening January or March, 1951. Address detailed application to Head, Department of Industrial Engineering, Montana State College, Bozeman, Montana.

MECHANICAL ENGINEER—Young Mechanical Engineer with a few years' experience in chemical plant operations. State training, qualifications and salary expected. Please direct reply to Personnel Office, Mathieson Chemical Corporation, Niagara Falls, N. Y.

Use a CLASSIFIED ADVERTISEMENT
for Quick Results

DEVELOPMENT ENGINEER—Graduate Mechanical Engineer 5 to 15 years' experience for product development and special machine design. Professional engineering organization engaging in product development and design for industrial clients. Work is interesting and diversified and offers opportunity for exercise of individual ingenuity. Address CA-3330, care of "Mechanical Engineering."

MECHANICAL ENGINEER—with textile experience in carding, spinning and weaving plants to become associated with a research organization servicing over one hundred textile mills. Ability to originate and carry through projects necessary. Salary four to five thousand. Address CA-3331, care of "Mechanical Engineering."

DEVELOPMENT or EXPERIMENTAL ENGINEER—Graduate engineer with five years' experience in applied engineering, preferably in development. Familiar with turbojet engines. Mechanical design ability with background in thermodynamics and combustion. Capable of supervising development tests and writing good reports. Please direct reply to Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

THERMODYNAMICIST—Graduate engineer to perform theoretical and design analysis of gas turbine type power plants. Must be analytical with practical realization of manufacturing problems. Background of thermodynamics, fluid dynamics, and heat transfer necessary. Five years' experience in applied engineering in these subjects. Must be capable of writing good reports. Please direct reply to Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

PROJECT ENGINEER—California. Process Plant Design and Project Engineer. Experience in pulp and paper and building materials plants preferred. Minimum five years' experience and engineering degree. Competitive salary depending upon individual qualifications. Address CA-3339, care of "Mechanical Engineering."

DESIGN DRAFTSMAN—for Mechanical Department large Copper Company Chile, South America. Thorough experience required design, detail, and checking of reinforced concrete and structural steel buildings, bridges, foundations and retaining walls. Experience mechanical design desirable but not essential. Graduate engineer with some practical experience U.S. preferred. Three-year contract, transportation both ways and salary while traveling paid by company. In reply give complete details. Address CA-3340, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER—with several years of design, construction and maintenance experience wanted for permanent position in sugar industry in Cuba. Salary open. Address CA-3345, care of "Mechanical Engineering."

MACHINE DESIGNER—Top-notch man wanted with wide experience designing variety of automatic machinery to design medium-weight high-speed automatic machines. Permanent, responsible position with national manufacturer. Location Northeast Ohio. State salary required and send complete resumé of education and experience with first letter. Address CA-3346, care of "Mechanical Engineering."

ENGINEER—for plant engineering section, central engineering division of nationally known company. Experience with small to medium size power plants essential. Experience in pulp or paper mill desirable, as well as in general design work. Wide variety of assignments covering general plant problems in all of company's diversified operations. Some traveling. Location Ohio. Address CA-3347, care of "Mechanical Engineering."

CONTROL VALVE DESIGNER—preferably young graduate engineer with some related experience. Exceptional opportunity to grow with progressive, nationally known company. Address CA-3353, care of "Mechanical Engineering."

MECHANICAL ENGINEERS—with design experience and ingenuity required for an aggressive Canadian firm manufacturing electronic and mechanical controls and instruments. Project engineers and junior engineers required. Salaries open. PSC Applied Research, 1450 O'Connor Drive, Toronto, Canada.

DEVELOPMENT ENGINEER—MECHANICAL—Engineer-Designer with creative ability and at least seven years' experience in the development of special purpose machinery and other production equipment. Experience in product development not desired. Good working conditions. Permanent. Send resumé. Address CA-3357, care of "Mechanical Engineering."

SALES ENGINEERS—with experience in the sales of mechanical equipment, wanted for positions as sales engineers for air handling apparatus for mechanical draft, heating and ventilating applications. Positions are available at various locations. Personal interviews will be granted only after receipt of written application giving full details of experience. Address Sturtevant Division, Westinghouse Electric Corporation, Dept. AH, Hyde Park 36, Boston, Massachusetts.

STEAM PLANT SUPERINTENDENT—Private electric utility building its first steam plant. Need a Mechanical Engineer with steam plant operating experience to act as resident engineer during construction, and then take charge of the operation of 60,000 KW plant. In reply furnish details on experience and qualifications, age, salary required, etc. Personnel Office, California Electric Power Company, P.O. Box 512, Riverside, California.

Continued on Page 116

Three Pages of "OPPORTUNITIES" This Month . . .114-116

POSITIONS WANTED

MECHANICAL ENGINEERING—Member of ASME; Age 48; Married; Registered Graduate Engineer, now employed, desires change for a more responsible position as Mechanical or Assistant Chief Engineer. Twenty years of diversified mechanical experience involving Design, Testing, Patent Developments, Inspection, and Administration Duties. Will travel if necessary. Address CA-3341, care of "Mechanical Engineering."

ENGINEER—25, married, MSME '48, TBII, Veteran Naval Engineer Officer, Licensed Marine Engineer, 2 1/2 years' experience oil field construction; maintenance; design of surface producing facilities, pipe lines, compressors, etc., corrosion, estimates, cost control. Desire change to East or Midwest. Will consider administrative or sales position. Address CA-3343, care of "Mechanical Engineering."

REGISTERED MECHANICAL ENGINEER—BSME, MSME, 9 years' experience consisting of research, teaching, design. Specialties are machine design, materials handling, and refrigeration. Creative and practical. Desires responsible position in any of above fields. At present employed. Address CA-3344, care of "Mechanical Engineering."

MECHANICAL ENGINEER—M.I.T. graduate, 5 years experience in production, maintenance and design, fluent Spanish and German, experience in Latin America, wishes connection with growing small or medium sized enterprise, if possible in field connected with control or electronics, where good work will bring advancement. Address CA-3349, care of "Mechanical Engineering."

PROFESSORSHIP OF APPROPRIATE GRADE—wanted by man 34, Ph.D. (Cornell), with varied experience teaching and research in applied mechanics: stress analysis, structures, elasticity, vibrations, and other branches. Address CA-3351, care of "Mechanical Engineering."

ENGINEERING DESIGNER, Inventor, specialist automatic machines, paper coating-processing desires to relocate with real progressive concern. Able take complete charge from idea to completed production. Location immaterial. Presently in executive capacity but no opportunity for further advancement. Salary $10,000.00. Available interview New York or Philadelphia. Address CA-3360, care of "Mechanical Engineering."

EXECUTIVE—B.M.E., M.Sc. Now employed. Available for responsible position offering larger opportunity. Industry or education. Broad experience including Chief Engineer, Assistant to President. Registered. Address CA-3361, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

A well established incorporated company desires TO REPRESENT A MANUFACTURER of high grade power plant equipment in Northern Ohio territory. Address CA-3283, care of "Mechanical Engineering."

MANUFACTURERS REPRESENTATIVE—established over 12 years in Pennsylvania, New Jersey and Delaware, desires additional line mechanical equipment. Can give complete engineering representation. Power Plant or Process Industry preferred though not essential. Address CA-3342, care of "Mechanical Engineering."

LINES WANTED—LINES WANTED—LINES WANTED—New manufacturer's agency and engineering office opening in Georgia wants lines as a manufacturer's agency starting Jan. 1st, 1951 on exclusive basis for either Georgia or Georgia and surrounding States. Hydraulic Devices and Machines, Mechanical and Electrical Power Transmission Equipment, Automatic Controls and Gages, items with a repetitive feature especially desirable. Present personnel consists of one Registered Engineer, one Textile, one Lubrication, one Sales Engineer. Send all details and proposition. Address CA-3350, care of "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

EXECUTIVES, ENGINEERS, DESIGNERS, SPECIALISTS—Our staff—technical graduates—serving both employer and applicant 20 years—no fee until placed—Bradley Placement Service, 555 Leader Building—Cleveland 14, Ohio.

ENGINEERS AND EXECUTIVES—This confidential service for outstanding men who desire positions paying $5,000 to $40,000 will develop preliminary negotiations with reputable organizations without risk to present position. For complete details, send experience record and expected salary range. Tomsett Associates, 1205-1 Berger Bldg., Pittsburgh 19, Pa.

ENGINEERS—Send brief qualification record for free listing of all current openings in your field. Rapid, confidential, nationwide service.

BOULEVARD ENGINEERING PERSONNEL SERVICE
116 South Michigan, Dept. C-1, Chicago 3, Ill.

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection, communicate with the undersigned. We offer the original personal employment service (40 years' recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 115 Dun Bldg., Buffalo, N. Y.

SALARIED PERSONNEL $3,000—$25,000
This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

JIRA THAYER JENNINGS
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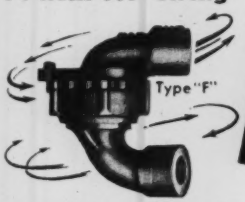
Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

. . . with 360° swing



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Precision-made Flexo Joints contain just four simple parts *completely* enclosed from grit and dirt — no springs . . . no small or complicated parts . . . no ground surfaces to wear.

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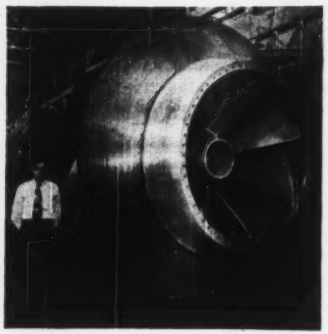

These Impellers were cast of our special "Turbine Runner Bronze"; Ult. Ten. Strength 80,000 lbs. p.s.i.; 40,000 lbs. Yield Point; 20% Elongation. Impellers are 145" outside diameter, and each pump is driven by 22,500 H. P.

Strength and resistance to erosion are the factors in selecting *"Turbine Runner Bronze"* for these enormous centrifugal pumps.

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- ✓ Handling repairs in your own plant?

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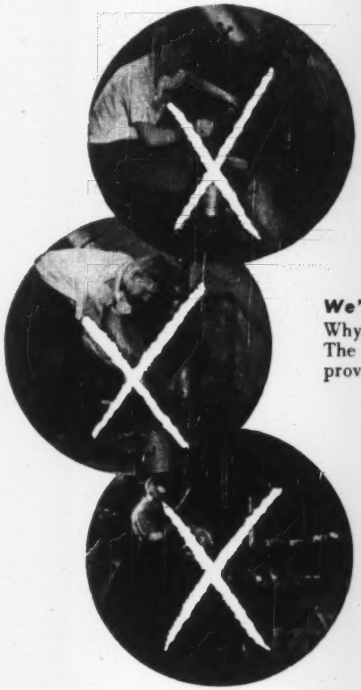

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We've eliminated lubrication.
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The above consultants are available
to work out solutions
to your engineering and management problems.

At the New York Telephone Company's Triangle exchange in Brooklyn, emergency batteries stand ready to deliver 3000 amperes for several hours.

How a whiff of stibine led toward lower telephone costs

In the Bell System there are a million lead storage battery cells connected to telephone circuits in the central offices. Current seldom flows in or out of these cells beyond the trickle which keeps them charged. In the rare event of power failure, however, they stand ready to supply the current for your telephone service.

Even in this stand-by service, cells require water to make up for electrolysis. And they consume power and eventually wear out. But Bell Laboratories chemists discovered how to make a battery which lasts many more years and requires less attention – by changing a single ingredient, the clue to which came unexpectedly from another line of their research.

The clue was a minute trace of stibine gas in battery rooms which electrochemists detected while on the lookout for atmospheric causes of relay contact corrosion. In small traces the gas wasn't harmful but to battery chemists it offered a powerful hint.

For stibine is a compound of antimony—and antimony is used to harden the lead grids which serve as mechanical supports for a battery's active materials. Tracing the stibine, the chemists discovered that antimony is leached out of the positive grid and enters into chemical reactions which hasten self-discharge and shorten battery life.

Meanwhile, in the field of cable sheath research Bell metallurgists had discovered that calcium could be used instead of antimony to harden lead. And theory showed that calcium would not react destructively in a battery. The result is the new long-life calcium-lead battery which cuts battery replacement costs, goes for months without additional water, and needs but ⅕ the trickle current to keep its charge.

It demonstrates again how diverse lines of research come together at Bell Telephone Laboratories to keep down the cost of telephone service.

BELL TELEPHONE LABORATORIES

Working continually to keep your telephone service big in value and low in cost.

Index To Advertisers

*Air Preheater Corp. 7
Allegheny Ludlum Steel Corp. 99
*Allis-Chalmers Mfg. Co. 21
*American Blower Corp. 84
*American Manganese Bronze Co. 116
*American Pulverizer Co. 60
ASME Publications 46, 72
*Armstrong Machine Works 3rd Cover
Aurora Pump Co. 60
Automotive & Aircraft Div., American Chain & Cable 108

*Babcock & Wilcox Co. 2nd Cover
*Barco Mfg. Co. 4
Barksdale Valves 111
*Barnes, Wallace, Co., Div. Assoc. Spring Corp. 20
Bell Telephone Laboratories 119
Boston Gear Works 12
Bruning, Charles, Co. 65
Brush Development Co. 101
*Buffalo Forge Co. 74
Bundy Tubing Co. 102, 103

Carrier Corp. 94
Clarage Fan Co. 122
Clark Equipment Co., Industrial Truck Div. 51
Cleveland Worm & Gear Co. 15
Climax Molybdenum Co. 49
*Cochrane Corp. 113
Cone-Drive Gears Div., Michigan Tool Co. 76
Cuno Engineering Corp. 91

*DeLaval Steam Turbine Co. 117
*Detroit Stoker Co. 25
Diamond Chain Co. (Inc.) 33
Dow Corning Corp. 44

Eastman Kodak Co. 73
Economy Pumps (Inc.) Div. Hamilton-Thomas Corp. 2
Edward Valves (Inc.) Sub. of Rockwell Mfg. Co. 14

Fenwal (Inc.) 61
Flexo Supply Co. 116
*Foster Engineering Co. 9

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*Foster Wheeler Corp. 27
*Foxboro Co. 96
*General Electric Co. 3, 85, 86, 93
General Radio Co. 106
*Gibson, Wm. D., Co., Assoc. Spring Corp. Div. 98
Graphite Metallising Corp. 52
*Grinnell Co. 13

Hamilton-Thomas Corp. 2
Hathaway Instrument Co. 54
Heating & Ventilating Exposition 43
Helicoid Gage Div., American Chain & Cable 55
Hilliard Corp. 111
Howell Electric Motors Co. 81

Imperial Tracing Cloth 68
International Nickel Co. 34
Irving Subway Grating Co. 64

Jenkins Bros. 40

*Kewanee Boiler Corp. 109
*Koppers Co., Fast's Coupling Dept. 77
Kunkle Valve Co. 110

Ledeen Mfg. Co. 66
Lefax 111
Linear (Inc.) 110
*Link-Belt Co. 75
Lovejoy Flexible Coupling Co. 112
Lukens Steel Co. 82
Lunkenheimer Co. 69

MB Mfg. Co. 30
*Marlin-Rockwell Corp. 5
Mercoid Corp. 54
*Miniature Precision Bearings 111
Morse Chain Co. 70, 71

*National Airoil Burner Co. 108
National Power Show 6
New Departure, Div. General Motors Corp. 1
*Newport News Shipbuilding & Dry Dock Co. 26
Nordstrom Valve Div. of Rockwell Mfg. Co. 17, 18
Northern Blower Co. 24

*Oilgear Co. 121
O'Neil-Irwin Mfg. Co. 43

Pacific Pumps (Inc.) 47
*Pangborn Corp. 56, 57
Permutit Co. 19
Philadelphia Gear Works 8
Physicists Research Co. 59
*Prat-Daniel Corp. 32

*R-S Products Corp. 80
*Republic Flow Meters Co. 28, 29
Revere Copper & Brass (Inc.) 95
Rockford Clutch Div. of Borg-Warner Corp. 108
*Roots-Connersville Blower Corp. 37

*Sarco Co. 39
Smooth-On Mfg. Co. 107
Sponge Rubber Products Co. 83
Standard Pressed Steel Co. 107
*Standard Stoker Co. 53
Stow Mfg. Co. 112
Streeter-Amet Co. 107
Stuart, D. A., Oil Co. 45

*Taylor Forge & Pipe Works 31
*Taylor Instrument Cos. 10, 11
*Terry Steam Turbine Co. 16
Thomas Flexible Coupling Co. 45
*Timken Roller Bearing Co. 4th Cover
*Tube Turns (Inc.) 62, 63

U.S. Electrical Motors (Inc.) 109
United Screw & Bolt Corp. 48

Vickers (Inc.) 105
*Vogt, Henry, Machine Co. 100

Walworth Co. 97
Waterman Engineering Co. 109
Westinghouse Electric Corp. 22, 23, 68
White, S.S., Dental Mfg. Co., Industrial Div. 58
*Wickes Boiler Co., Div. of Wickes Corp. 79
Wiley, John & Sons 64
*Wing, L. J., Mfg. Co. 67
Wollensak Optical Co. 78

*Yarnall-Waring Co. 35

CONSULTING SERVICE . . . Page 118

Armstrong, Cecil W. & Assoc.
Barnard, S. Bertrand
Black & Veatch
Brown Engineering Co.
Coleman, W. B. & Co.
Ehrco Die Casting Service
Fries, Peter, Jr.
Hathaway, C. M.
Kendall, George H.
Lancaster, Allwine & Rommel
MB Design Consultants (Inc.)
Myers & Addington
National Weld Testing Bureau
Nuclear Development Associates
Polachek, Z. H.
Sanderson & Porter
Sargent & Lundy
Sirrine, J. E., Co.
Stanley Engineering Co.
Tour, Sain & Co.

Advertisers in previous 1950 issues but not in this issue

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*Barnes-Gibson-Raymond, Div. Assoc. Spring Corp.
Biddle, James G., Co.
Briggs & Stratton Corp.
Brown & Sharpe Mfg. Co.
*Brownell Co.

Cassell, John R., Co.
Central Scientific Co.
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Consolidated Engineering Corp.
*Crane Packing Co.
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Dowell (Inc.)
*Downingtown Iron Works
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DuMont, Allen B., Labs.

Eagle Pencil Co.
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Fafnir Bearing Co.
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Farval Corp.
*Foote Bros. Gear & Machine Corp.
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*Gear Specialties (Inc.)
Giannini, G. M. & Co.
*Gifford-Wood Co.
*Goulds Pumps (Inc.)

Haering, D. W. & Co.
*Hamilton Mfg. Co.
Hyatt Bearings Div., General Motors Corp.
Hydropress (Inc.)

*James, D. O., Gear Mfg. Co.
*Jeffrey Mfg. Co.
*Johns-Manville
*Johnson, Carlyle, Machine Co.
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Robertson, John, Co.
*SKF Industries (Inc.)
*Schutte & Koerting Co.
Smith, Winfield H., Corp.
*Voss, J. H. H., Co.
Wisconsin Motor Corp.
Wolverine Tube Div., Calumet & Hecla Consolidated Copper Co.
Wood's, T. B., Sons Co.
*Zurn, J. A., Mfg. Co.

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Page No.	*Name of Advertiser*

Name _____ Title _____

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Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

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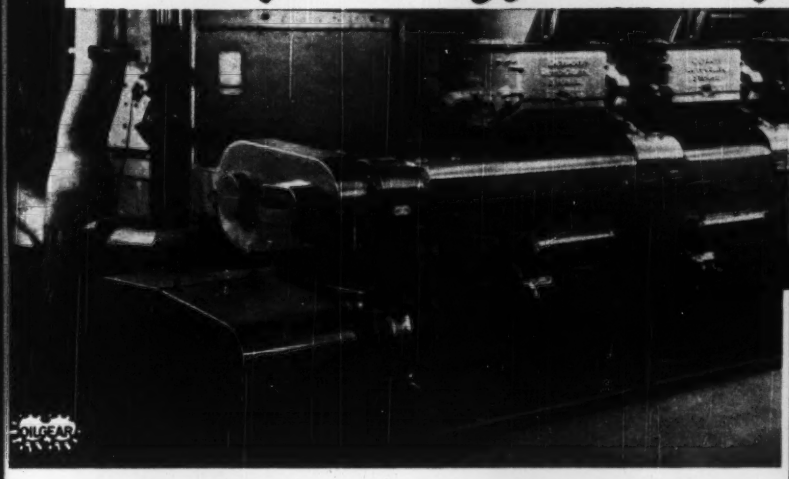
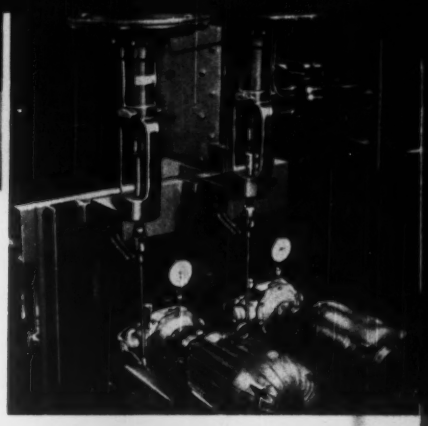


View in J. I. Case Co. tractor works at Racine, Wis. Boiler front and Detroit Roto-Grate Stoker on 100,000 lb. per hr. boiler unit.



Two Oilgear Variable Delivery Pumps with simple diaphragm actuated hydraulic servomotor lever controls supply fluid power for the fuel feed and grate drives. An Oilgear drive was experimentally installed on the fuel feed on the first stoker in 1948. On the basis of its performance, Oilgear drives were used for both fuel feed and traveling grate on a second stoker unit installed in 1949. Also, Oilgear will replace the mechanical grate drive on the first stoker installed in 1943. Like a shadow, flexible, controllable Oilgear *Fluid* Power causes fuel feed rate and grate speed to accompany steam demand up and down. Recording charts show steam *demand* varies "all over the place," but steam pressure and fuel air ratio stay steady.

And Oilgear's Range and Control help capture savings hidden in J. I. Case 100,000 lb. Boiler Unit

The 100,000 lb. per hour boiler unit in the J. I. Case Co. tractor works at Racine, Wisconsin, has demonstrated that it is one of the highest efficiency units in the United States. To obtain such high efficiency, careful tests of variable speed drives for fuel feed and grate travel were made during two years. Finally, Case engineers selected Oilgear Fluid Power Drives, for, as Mr. Cole H. Morrow, Chief Plant Engineer says, the Oilgear units proved far superior to electric drives and mechanical transmissions under actual operating conditions.

SMOOTH, POSITIVE SPEED VARIATION "In order to obtain high efficiency in any boiler unit," says Mr. Morrow, "*a very precise variable speed fuel feed drive* is required to meet widely varying demand. The Oilgear Drive gives smooth, positive variable speed operation from zero to 100% of capacity with a straight line fuel feed characteristic. This allows us to calibrate the control system for operation within amazingly close limits of fuel-air ratio variation.

EASE OF CONTROL "Also, on this type of stoker the grate speed must be infinitely variable from minimum to maximum yet maintained in direct proportion to the rate of fuel feed. Every change in fuel feed requires an immediate and directly proportionate change in grate speed. (Such synchronization) is easily obtained with the Oilgear drive units because of their ease of control, and the simplicity and low force requirements of the control mechanism."

UNLIMITED SPEED RANGE Also, fuel feed and grate drives must have a range of speed at least equal to the demand range. Most drives have a range not exceeding 4 to one. Yet at Racine, during the summer, demand drops far below the 25,000 lb. threshold imposed by such a ratio. The Oilgear Drives however have no "ratio" limits, would function down to zero load if necessary. In fact, they give precise load control down to a load of 15,000 pounds per hour normally obtained each day during the summer, and down to as low as 5,000 pph over the weekends still under full automatic control.

OUTSTANDING RELIABILITY "One of the outstanding features we discovered . . . was the *reliability of the Oilgear units*. The experimental installation operated almost continuously for a year and a half without any difficulty. This record was far better than we were able to obtain with any other type of drive or transmission."

These four features, variability, ease of synchronization and control, actual range from zero fpm, rpm or torque up to maximum, and reliability proven over and over again, are indications of the many advantages Oilgear drives and transmissions offer in machine design and use. Investigate Oilgear equipment as a *better* solution for your problems. THE OILGEAR COMPANY, 1570 West Pierce Street, Milwaukee 4, Wisconsin.

Oilgear

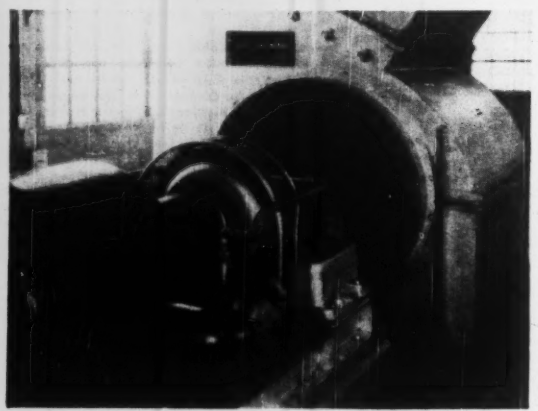
PIONEERS IN FLUID POWER
PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

Consumers Power *Again* Selects

CLARAGE FANS

. . . for Both Forced and Induced Draft

Built in 1940 — enlarged to practically twice capacity in 1949 — and *both times* Clarage HEAVY-DUTY equipment was chosen for mechanical draft in this John C. Weadock plant, Bay City, Michigan.



One of the four Clarage forced draft fans; each 100,000 c.f.m. at 12" S.P. There are also two Clarage induced draft fans included in this latest Weadock power plant installation; each with a capacity of 330,000 c.f.m. at 17" S.P., 350° F.

All told, Consumers Power Company has had 24 years of experience with Clarage forced and induced draft fans. Other installations include: East Ave. Station, Kalamazoo (1926); Elm St. Station, Battle Creek (1938); Bryce C. Morrow Station, Comstock, Michigan (1939).

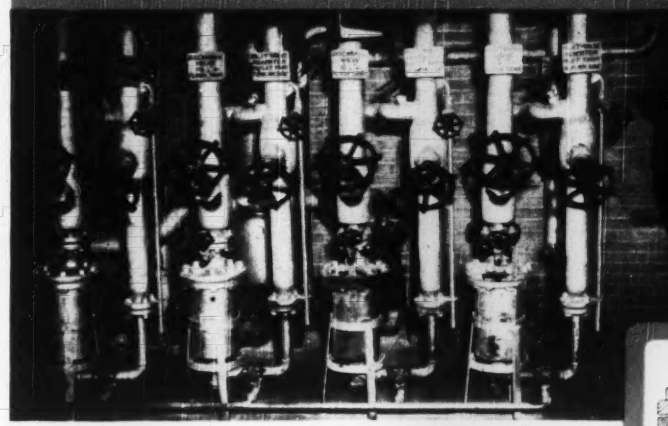
Specialists in this exacting field of mechanical draft, we have facilities to meet all requirements. To date over 3,000 power plants are Clarage equipped. If you are looking for the *best in performance* and *dependability*, it will pay you to consult with us.

CLARAGE FAN COMPANY
KALAMAZOO, MICHIGAN

CLARAGE
—HEADQUARTERS for Air Handling and Conditioning Equipment

Sales Engineering Offices in All Principal Cities

FORGED STEEL steam traps



List of Materials

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Up to 600 psig — S.A.E. 1030 steel
600 to 900 psig — ASTM F-1 moly-steel
900 to 1500 psig — ASTM F-7 chrome moly-steel

VALVE AND SEAT:
Chrome steel, heat treated

BUCKET and VALVE LEVER ASSEMBLY:
18-8 Stainless Steel

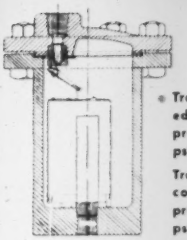
BOLT and NUT SET:*
Bolts Class C, 125,000 lbs. tensile
Nuts, hex, semi-finish, S.A.E. 1030

GASKET:*
Compressed graphited asbestos

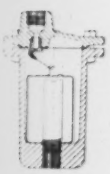
*Does not apply to No. 3211 nor No. 913

1. FOR HIGH PRESSURE SERVICE — engineers responsible for the design or operation of high pressure, high temperature steam plants can specify with confidence Armstrong Forged Steel Steam Traps to provide completely automatic condensate drainage throughout. These traps are "standard" in leading power stations throughout the entire world where they are used for draining headers, desuperheaters, soot blowers and other drip points at pressures as high as 2400 psig! These traps always open when filled with condensate and there is no steam loss under no-load conditions. Safety and dependability are assured through use of modern materials, highest quality workmanship and critical inspection.

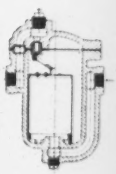
2. FOR ALL-STEEL INSTALLATIONS — Armstrong Forged Steel Traps also ideally meet the increasing demand in power plants, refineries and general industry for all-steel fittings on lower pressures (up to 250 psig) because they are light in weight and surprisingly low in price. They provide the maximum in safety, dependability, shock and fire resistance.



- Traps with screwed connections for pressures to 900 psig.
- Traps with flanged connections for pressures to 2400 psig.



- No. 3211 trap for pressures to 250 psig, only $14.00.



- Side inlet cast steel trap for pressures to 600 psig, screwed or flanged connections.

- FOR COMPLETE DATA ask for the 36-PAGE ARMSTRONG STEAM TRAP BOOK or see our catalog in Sweet's.

ARMSTRONG MACHINE WORKS
894 Maple Street, Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

Honing machine with a 96-foot stroke gets precision with TIMKEN® bearings

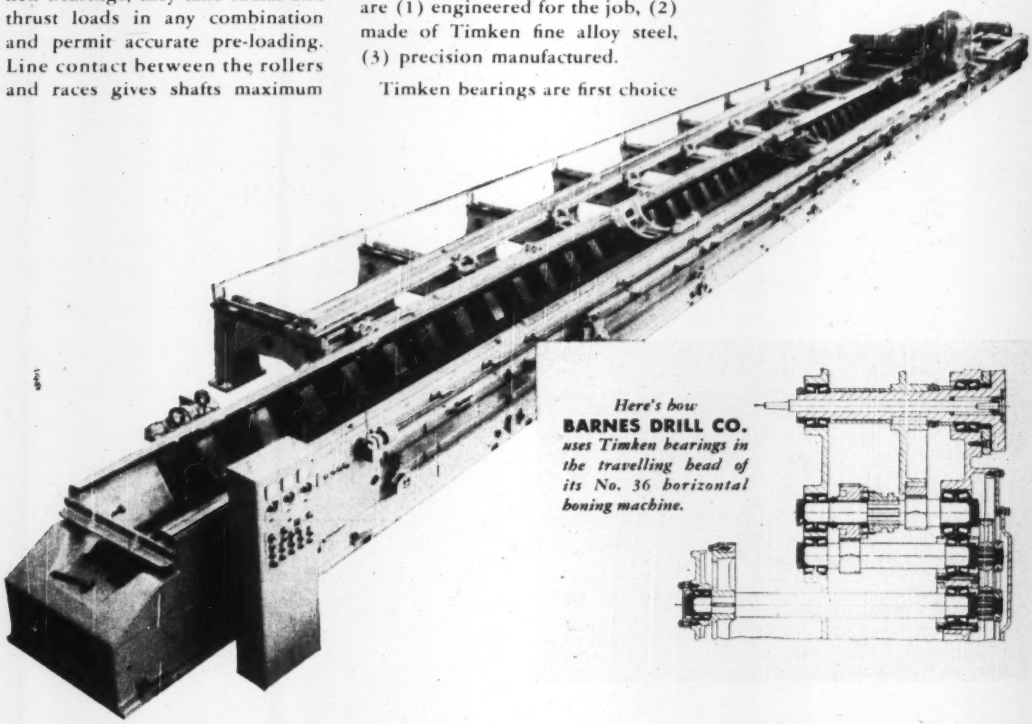
WHEN honing the inside of a long precision tube, a smooth-running spindle with steady, precise rotation is of major importance. That's why the Barnes Drill Company uses Timken® bearings on this No. 36 horizontal honing machine built for the Watervliet Arsenal. Eight Timken bearings are used in the headstock.

Due to the tapered design of Timken bearings, they take radial and thrust loads in any combination and permit accurate pre-loading. Line contact between the rollers and races gives shafts maximum support. Gears mesh correctly, vibration is eliminated and wear on moving parts is prevented. Incredibly smooth surface finish and true rolling motion practically eliminate friction. And because Timken bearings permit tighter closures, maintenance and lubrication are cut to a minimum.

Timken bearings normally last the life of the machine because they are (1) engineered for the job, (2) made of Timken fine alloy steel, (3) precision manufactured.

Timken bearings are first choice throughout all industry. No other bearing can give you *all* the advantages you get with Timken bearings. Look for the trade-mark "Timken" on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **BARNES DRILL CO.** *uses Timken bearings in the travelling head of its No. 36 horizontal honing machine.*

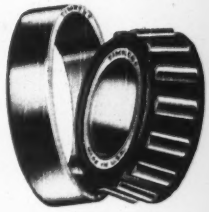
DESIGN LEADERSHIP

The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roll ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TAPERED ROLLER BEARINGS



NOT JUST A BALL · NOT JUST A ROLLER · THE TIMKEN TAPERED ROLLER · BEARING TAKES RADIAL · AND THRUST · LOADS OR ANY COMBINATION